ILLINOIS NATURAL AREAS INVENTORY

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TECHNICAL REPORT

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ILLINOIS NATURAL AREAS INVENTORY

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ILLINOIS DEPARTMENT OF CONSERVATION

by the

DEPARTMENT OF LANDSCAPE ARCHITECTURE
UNIVERSITY OF ILLINOIS · URBANA-CHAMPAIGN

and the

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Illinois Department of Conservation personnel responsible for preparing the Request for Proposals and coordinating the work included John Schwegman, contract liaison officer, and Dr. Edward Hoffman, Dr. Robert Lee, Marlin Bowles, and Robert Schanzle.

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For additional Information

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Plants, and loaned his unpublished notebooks of information about natural areas in southern Illinois.

Dr. Robert A. Evers of the Illinois Natural History Survey graciously made available the information he had compiled during a career of studying Illinois' natural areas and flora.

Dr. Philip W. Smith and Dr. Lawrence M. Page of the Illinois Natural History Survey shared the Survey's information about endangered animals and compiled a list of outstanding aquatic areas. Michael A. Morris of the Natural History Survey, working through the Endangered Species Project, compiled distribution records of endangered animals for the Inventory.

Dr. Robert F. Betz inspired and encouraged the survey of cemeteries by sharing his knowledge gained by evaluating over 800 cemeteries for prairie remnants in northern Illinois. Dr. Betz has pioneered in the study, restoration, and preservation of cemetery prairies.

Dr. Jean W. Graber and Dr. Richard R. Graber of the Illinois Natural History Survey provided a wealth of information and many hours of discussions about endangered birds.

Personnel at the Department of Conservation's deer hunter check stations, coordinated by Forrest Loomis, distributed a questionnaire about endangered animals to deer hunters.

Dr. Brooks M. Burr and students at Southern Illinois University conducted surveys of fishes in certain lakes and streams for the Inventory.

Robert Walker and Donald Greene generously shared the results of an unpublished survey of outdoor classrooms by the Conservation Committee of the Illinois Chapter of the Soil Conservation Society of America.

Don Roderick of the Illinois Office of Education assisted in mailing a questionnaire about use of natural areas to the elementary and secondary schools in Illinois.

Seventy people took responsibility for surveying cemeteries for prairie and savanna remnants. Other people who joined these 70 volunteers to survey certain counties remained anonymous to the Inventory.

Perhaps it is best not to attempt an incomplete listing of participants, but one person deserves special mention: Dr. Paul Shildneck surveyed cemeteries in all or part of 14 counties.

The Inventory benefited from a series of workshops on endangered species, conducted by the Endangered Species Project. In addition to staff from the Inventory and the Endangered Species Project, the following people participated in the workshop on fishes: Dr. William Southern (Endangered Species Protection Board), Dr. Philip W. Smith (Illinois Natural History Survey), Dr. Lawrence M. Page (Illinois Natural History Survey), Michael A. Morris (Illinois Natural History Survey), Dr. Larry John (Western Illinois University), Dr. Leonard Durham (Eastern Illinois University), Larry Dunham (Department of Conservation), and Dr. Brooks M. Burr (Southern Illinois University).

The following attended the workshop on amphibians and reptiles: Harlan Walley (Northern Illinois University), Dr. Gordon Thurow (Western Illinois University), Dr. Philip W. Smith (Illinois Natural History Survey), John E. Schwegman (Department of Conservation), Alan Resetan (Field Museum of Natural History), John Murphy (Chicago Herpetological Society), Michael A. Morris (Illinois Natural History Survey), Dr. Edward O. Moll (Eastern Illinois University), Richard Funk (Illinois State University), Dr. Lauren E. Brown (Illinois State University), Dr. Ronald A. Brandon (Southern Illinois University), and Dr. Ralph W. Axtell (Southern Illinois University).

The mammals workshop was attended by: Harlan Walley (Northern Illinois University), Dr. Howard Stains (Southern Illinois University), Dr. Glen C. Sanderson (Illinois Natural History Survey), Dr. Donald F. Hoffmeister (University of Illinois), Dr. William G. George (Southern Illinois University), Dr. Dale E. Birkenholz (Illinois State University), and Dr. Richard D. Andrews (Eastern Illinois University).

Participants in the workshop on endangered birds were: Dr. William E. Southern (Endangered Species Protection Board), Vernon Kleen (Department of Conservation), Dr. S. Charles Kendeigh (University of Illinois), Lee G. Johnson (Natural Land Institute), Dr. L. Barrie Hunt (Eastern Illinois University), Dr. Richard R. Graber (Illinois Natural History

Survey), Dr. Jean W. Graber (Illinois Natural History Survey), Donald M. Elsing (U. S. Forest Service), Marlin Bowles (Department of Conservation), H. David Bohlen (Illinois State Museum), Dr. Richard G. Bjorklund (Bradley University), and Dr. Dale E. Birkenholz (Illinois State University).

The workshop on endangered plants included: Gerould S. Wilhelm (The Morton Arboretum), Dr. Julius Swayne (Rend Lake Community College), Dr. Paul Shildneck, John E. Schwegman (Department of Conservation), Raymond Schulenberg (The Morton Arboretum), Dr. Kenneth R. Robertson (Illinois Natural History Survey), Jerry Nilsson (U. S. Forest Service), Dr. Lorin Nevling (Field Museum of Natural History), Dr. Robert H. Mohlenbrock (Southern Illinois University), Roger McMannis (U. S. Fish and Wildlife Service), Walter Matia (The Nature Conservancy), Dr. Alfred C. Koelling (Illinois State Museum), Dr. Almut Jones (University of Illinois), Dr. Robert D. Henry (Western Illinois University), Dr. John E. Ebinger (Eastern Illinois University), and Carter D. Christenson (Soil Conservation Service).

Participants in these workshops provided information to the Inventory not only at the workshops, but by sharing their personal knowledge and making available personal and institutional records and collections at other times.

In addition to the people who participated in the endangered species workshops, the following people assisted the Inventory by providing information about natural areas or by making facilities available to the project: Dr. John Warnock (Western Illinois University), Douglas Wade (Northern Illinois University), Floyd Swink (The Morton Arboretum), Doris Sublette (Illinois Natural History Survey Library), Dr. Paul D. Sorenson (Northern Illinois University), Dr. Peter Schramm (Knox College), Jean Ray (Morris Library, Southern Illinois University), Donald Pretzsch (Soil Conservation Service), Dr. W. D. Klimstra (Cooperative Wildlife Research Laboratory, Southern Illinois University), G. Tim Keller, Corliss I. Ingels, Dr. Stanley E. Harris, Jr. (Southern Illinois University), Dr. James Hardin (Cooperative Wildlife Research Laboratory, Southern Illinois University), Philip Hanson (Field Museum of Natural History), Neil Gaston (Illinois Chapter, The Nature Conservancy), Thomas Walkington (Illinois

Chapter, The Nature Conservancy), Howard Fox (University of Illinois), Henry Eilers, Dr. Ben L. Dolbeare (Sangamon State University), Margaret Irene Cull, and David Cobb (University of Illinois Library).

Many other people and agencies assisted the project. Conservation districts and forest preserve districts provided information about areas in their jurisdictions. The Agricultural Stabilization and Conservation Service (ASCS) of the U. S. Department of Agriculture provided work space for the Inventory staff to examine aerial photos in each county ASCS office, loaned aerial photos, and provided information about potential natural areas. District Conservationists of the U. S. Department of Agriculture's Soil Conservation Service and District Foresters of the Illinois Department of Conservation provided information about many natural areas. A skillful and enthusiastic group of pilots from flight services throughout Illinois contributed to the efficiency of the fieldwork. The Illinois Speleological Survey made its files on 300 caves available to the Inventory.

This report should perhaps have at least a dozen authors, including each of the natural area ecologists. The staff members formed a dedicated and unselfish group, willing to work under continual deadlines and unwilling to produce less than their best possible efforts. They worked far longer than an 8-hour day on countless occasions and many continued to work for the project after they had left the payroll. The privilege of writing the final report fell to the survey director, but the fieldworkers continued to help. In a few instances, it was possible to share authorship of sections of this report with another staff member who wrote a part of the text. Ten former staff members reviewed the report and suggested many improvements. Francis M. Harty was especially adept and diligent in constructive criticism of the report.

John White
November 1978

The Illinois Natural Areas Inventory was a 3-year project to find and describe natural areas for the Illinois Department of Conservation. The results of the inventory will be used to develop and implement a state natural area plan, to protect the diversity of natural features in Illinois.

Methods for finding natural areas consisted of compiling available information, examining maps and aerial photos, aerial surveys, and on-site inspections. As many as 90 items of information were compiled for the significant sites. A computer-based system was developed to store, retrieve, and analyze the information.

The 1,089 sites identified as natural areas have a total of 1,730 significant features. Six hundred and ten natural areas were identified because of their high quality, relatively undisturbed communities of plants and animals. There are 269 areas with endangered species, 160 outstanding geologic areas, and 17 outstanding aquatic areas. Two hundred and fifty-one areas are nature preserves or school natural areas.

The approximate acreages of high quality, relatively undisturbed areas of land and water identified by the Inventory are as follows: 13,500 acres of forests, 2,300 acres of prairies, 1,300 acres of savannas, 6,000 acres of wetlands, 2,000 acres of lakes and ponds, and 600 acres of rocky glades and similar communities. These relatively undisturbed areas include seven-hundredths of 1% of Illinois' total land and water area.

The natural areas represent a wide diversity of natural features. Most geologic formations, major soil associations, and topographic features occur in at least one site listed by the project. Natural areas were found in all but three counties, but they are concentrated in hilly regions, along rivers, and near cities.

About one-third of the natural areas are receiving some degree of protection, but only one-fifth of the significant natural features can be considered permanently protected. Half of the areas are threatened with destruction from changes in the use of the land.

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ILLINOIS NATURAL AREAS INVENTORY TECHNICAL REPORT

VOLUME I
SURVEY METHODS AND RESULTS

John White

Illinois Natural Areas Inventory
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We are especially grateful to the hundreds of landowners who granted permission to visit their properties.

The Inventory's natural area ecologists were responsible for the majority of work on this project. The ecologists were as follows: L. Keith Wilson, Francis M. Harty, and Gerald Paulson (northern Illinois); John A. Bacone (central Illinois); Douglas C. Wallace (western Illinois); Randy W. Nyboer (southwestern Illinois); and Max D. Hutchison and Donald R. Kurz (southern Illinois). Each of these people was responsible for all aspects of the survey work in a particular part of the state.

The following people were field assistants: Erica L. Rowe, John T. Reeves, William P. Pusateri, Thomas Post, Warren Netherton, Robbin C. Moran, Julian J. Lewis, Michael A. Homoya, Margaret M. Foster, and Donald Coons.

Technical assistance in the main office was provided by David Studtman, Carol Qualkinbush, Kathleen Finney, Donna Evans, Jeffrey Acker, Thomas Brown, and Stephen England.

Three assistants had major, independent responsibilities that were at the same level as natural area ecologists but were more specialized: Michael H. Madany (field surveys, classification), Kathryn Kerr (Category II, IV, and V areas; caves), and Marilou Hinrichs (preparation and computerization of the natural area data).

Dr. Fakhri A. Bazzaz of the University of Illinois was always a willing advisor and friendly critic of inventory methods.

The staff at the Natural Land Institute's main office in Rockford worked closely with the Inventory. George B. Fell provided advice and consultation throughout the project. Work was coordinated and shared with the Natural Land Institute's Endangered Species Project, directed by Richard H. Thom and Dr. Charles J. Sheviak. Jean Sheviak compiled summaries of collection records for the Inventory, and Mark Ritke worked with the Inventory on endangered species as a student intern from Eastern Illinois University.

Clerical and secretarial work was provided by Marilou Hinrichs, Candy Willut, Jo Powell, Celeste Conner, Ada Siler, Darlene Graves, and Gladys Campbell. Joyce Hipskind typed the final draft of this report.

Marilou Hinrichs prepared the photographic prints, and John Richardson supplied photographic assistance. Plate 1 is from the University of Illinois Cooperative Extension Service. Plates 2, 3, 7, and 8 are by Marilou Hinrichs. Plate 4 is redrawn from the unpublished *Presettlement Vegetation Atlas of Illinois*, by John White. Plate 5 is from the U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service. Plates 6 and 9 are by John White, and Plate 10 is by Marlin Bowles. Donna Evans and Jo Powell prepared the figures.

John E. Schwegman of the Department of Conservation's Natural Areas Section served as project coordinator and contract liaison officer. Robert Schanzle and Marlin Bowles, also of the Natural Areas Section, helped define the Department of Conservation's information needs in relation to the natural area survey.

Many people outside the Inventory staff contributed to the project. These people gave freely of their time, skills, and knowledge as a contribution toward natural area preservation, without reimbursement and often at additional personal expense. The project benefited greatly from the ambitious efforts and diversity of interests of these volunteers. The contributions of several people deserve special mention.

Dr. H. B. Willman of the Illinois State Geological Survey, in his typical style, provided an excellent compilation of geologic areas. Dr. Willman developed the classification systems for topographic features that were used by the Inventory.

Dr. John E. Ebinger of Eastern Illinois University contributed hundreds of hours of enthusiastic fieldwork and herbarium work to the Inventory.

Dr. Robert H. Mohlenbrock of Southern Illinois University generously shared his encyclopedic knowledge of vascular plants in Illinois, allowed us to use a prepublication draft of *Distribution of Illinois Vascular*

Plate 1. County map of Illinois.

PART I
INTRODUCTION

The basic goals and accomplishments of the Inventory are presented in Part I. The values of natural areas are described, and the importance of an inventory is explained.

Plate 2. *The Middle Fork of the Vermilion River. This outstanding aquatic area is the only known habitat for the bluebreast darter in Illinois. Four other natural areas were identified along this central Illinois stream.*

Section 1.
SUMMARY

An inventory of natural areas in Illinois was completed in 1978 by the University of Illinois and the Natural Land Institute under a contract with the Illinois Department of Conservation. The 3-year project consisted of surveys to find, evaluate, describe, and classify natural areas of statewide significance. A computer-based information system was developed to store, retrieve, and analyze the natural area data. The results of the inventory will be used to develop and implement a plan to protect the natural features in Illinois.

The inventory was a search for the following kinds of significant features:

(1) Relatively undisturbed terrestrial or wetland natural communities
(2) Habitats with endangered or threatened animals or plants
(3) Habitats with relict species
(4) Outstanding geologic features
(5) Nature preserves or areas used for natural science studies
(6) Areas with unique natural features
(7) Outstanding aquatic areas

The following classification systems were developed to aid in collecting and analyzing the information:

(1) Categories and lists of significant features, which are the features that allow a site to qualify as a natural area
(2) A classification of natural communities of plants and animals
(3) A system of grades for describing the effects of disturbance to an area
(4) A classification of topographic features
(5) Other terms for describing and mapping an area's natural and cultural features

The various kinds of natural areas were inventoried with separate surveys, based on different sources of information. Sites with relatively undisturbed terrestrial or wetland communities were found mainly

with original searches. Sites with relict species were also found by field surveys. Habitats with endangered species were inventoried by relying mainly on available information, supplemented with fieldwork. The Illinois State Geological Survey compiled a list of outstanding geologic areas. The Illinois Natural History Survey recommended outstanding natural lakes and streams. Nature preserves and school natural areas were found through publications and mailed questionnaires.

The surveys were processes of selecting potential natural areas, examining them, and rejecting the sites that did not qualify. Each stage of the survey relied on the previous stage and examined the remaining areas in more detail. The stages were as follows:

- Compiling available information
    - Gathering background material
    - Contacting people and agencies
    - Reviewing literature
- Examining maps and aerial photographs
- Aerial survey
- Initial ground survey
- Final field survey

Inventories of geologic areas, aquatic areas, and school natural areas were conducted almost solely by compiling available information.

Many people and agencies contributed information about areas, especially habitats with endangered species. The Natural Land Institute's Endangered Species Project shared the responsibility for compiling records of endangered species from people, organizations, publications, museums, and herbaria. Specialists provided information about the current distribution and population status of endangered species in a series of workshops.

A literature review revealed over 1,400 references to areas identified by the Inventory and about 1,700 other publications about the ecology or field biology of Illinois.

The survey of relatively undisturbed natural communities relied largely on maps and aerial photos to eliminate disturbed areas and to select possible natural areas. All potential sites were surveyed in the

field. Approximately 5,000 potential natural areas were considered in this part of the inventory. Surveying from an airplane proved effective and efficient for screening the sites.

Special surveys were conducted to find prairie and savanna remnants on railroad rights-of-way and in cemeteries. All 11,000 miles of railroad in Illinois with potential for prairie remnants were surveyed, as were 3,923 cemeteries in the prairie regions of the state.

As many as 90 items of information were compiled for the natural areas. These included (1) basic information such as the area's name, boundaries, significant features, location, and acreage, (2) descriptions of natural characteristics such as natural communities, plant communities, degree of disturbance, geology, topography, and soils, (3) information about the area's use such as ownership, management, preservation status, and threats of destruction, (4) a discussion of preservation values, and (5) supplemental materials such as species lists, vegetation sampling data, and literature citations.

A total of 1,089 natural areas were listed. Some natural areas have more than one significant feature. The number of significant feature occurrences are as follows:

689	high quality terrestrial or wetland natural communities
521	habitats with endangered species
45	habitats with relict species
160	outstanding geologic features
266	nature preserves or school natural areas
30	unique natural features
17	outstanding lakes or streams

In addition, many other exceptional features were found. Exceptional features are not important enough to be the reason for identifying a natural area, but they were listed when they occurred at a site identified for some other, significant feature. For example, 910 occurrences of habitats with exceptional (rare or threatened) species were identified.

The acreages of high quality natural communities identified by the Inventory are as follows:

Forests	13,484
Prairies	2,352
Savannas	1,296
Wetlands	6,029
Lakes and ponds	1,960
Glades and similar communities	602

These relatively undisturbed areas include seven-hundredths of 1% of Illinois' land and water.

The natural areas represent a wide variety of natural features. Most geologic formations, major soil associations, and topographic features in Illinois occur in at least one site listed by the Inventory. Natural areas were found in all but three counties, but they are concentrated in hilly regions, along rivers, and near cities.

Slightly more than half of the natural areas are in private ownership, and are not protected by the owner; and half of the areas are threatened with destruction from changes in use of the land. About one-third of the natural areas are receiving informal or formal protection, but only one-fifth of the occurrences of significant natural features can be considered permanently protected.

The project was as thorough as practical within limits of time and money and within the guidelines set by the Department of Conservation. The Inventory found that compiling available information must be supplemented by original searches and fieldwork to assure accurate and uniform information.

Section 2.
INTRODUCTION

Purpose of the Illinois Natural Areas Inventory

The Illinois Natural Areas Inventory was a systematic effort to find, evaluate, describe, and classify natural areas for the Illinois Department of Conservation. The purpose was to provide accurate and detailed information about the location and characteristics of natural areas of statewide significance.

Scope of this Report

This report describes the methods and summarizes the results of the surveys. The Inventory's computer system is described in an accompanying report. The Illinois Department of Conservation and Illinois Nature Preserves Commission are using information compiled by the Inventory to develop and implement a plan to preserve natural areas in the state.

Importance of Preserving Natural Areas

A detailed discussion of the value of natural areas is beyond the scope of this report, but others have treated the subject ably. A report entitled *The Preservation of Natural Diversity: A Survey and Recommendations* by The Nature Conservancy (Humke, et al., 1975) reviews the need for preserving natural diversity and emphasizes the vital role of natural ecosystems in maintaining a healthy environment. Complex natural ecosystems are stable and can restore themselves when disrupted, provided that the diversity of natural organisms is maintained. However, disruption and destruction of natural areas is so widespread and continual that it is now necessary to preserve and actively protect natural areas.

A discussion of the need for preserving natural areas is in the *Guidelines* for the Illinois Nature Preserves System (Fell, et al., 1972) These reasons are summarized in the Commission's *Two-year Report* (Illinois Nature Preserves Commission, 1973) as follows:

In this day of tremendous technological advancement there can be no question of the value of basic scientific research. Natural areas are resource materials from which new knowledge can be derived. As scientists learn more about the world of nature, they are increasingly aware of the tremendous loss that will be suffered with the impending annihilation of natural communities all over the world. The loss in real wealth from the extinction of living forms is beyond comprehension. Natural areas can serve as check areas in studies relating to air, water, and soil pollution. Gaining a greater knowledge of wild communities and populations can lead to a better understanding of the growing problems of human society, urban environment, and population control, and serve valuable functions in research in many aspects of land management.

Natural areas serve as outdoor classrooms for students of all levels, from grade school through college. They provide a teaching resource to fill the need of contact with the world of nature.

Plants and animals have evolved into a bewildering diversity of forms, varying in infinite detail with their adaptation to varying climates, soils, and living conditions. Researchers find that the wild relatives of domesticated species are valuable sources of new genetic material. The plants and animals man uses are only a tiny fraction of the wild things that inhabit the earth. The potential usefulness of the others is unknown but doubtless enormous. We are constantly discovering new uses and products from wild plants and animals previously unexploited.

Many forms of life will perish from the earth if we do not spare bits of their native habitats as havens from the flood of civilization. Simply to keep on earth the awe-inspiring myriad array of living things is our obligation to future generations. We should also recognize that these creatures have a right to a place on earth.

Natural areas are sources of beauty and inspiration, both as scenery and in the more intimate sense of the form and color of individual groups of living things.

Natural areas also serve as living museums--examples of the rich and diverse natural world from which the pioneers built this country. They are historic memorials that serve as living links with the primitive past in such a way as to enhance our understanding and perception of the world we live in.

Need for a Comprehensive Natural Areas Inventory

Many people and agencies own, manage, and use areas with outstanding natural values. Private landowners hold and personally protect many natural areas, and interested citizens watch and manage nature preserves. Federal agencies such as the Forest Service, Fish and Wildlife Service, and Army Corps of Engineers manage lands with significant natural area

values. Local agencies, including forest preserve districts, conservation districts, park districts, zoning boards, and planning commissions participate in the protection and use of natural areas. Schools at all levels own and use natural areas for teaching and research. Private preservation groups such as the Natural Land Institute and The Nature Conservancy are responsible for preserving many of Illinois' most outstanding natural areas. The State of Illinois is involved with natural areas through its various departments and commissions, especially the Department of Conservation and Nature Preserves Commission. Our natural heritage is assured increased protection when these concerned individuals and groups are aware of the location and significance of natural areas. More natural areas are destroyed through ignorance than are lost because people are aware of them and abuse them.

The Department of Conservation protects natural areas by acquiring and managing certain areas, by analyzing proposals for publicly regulated development projects, and by distributing money to local governments for land acquisition. The Illinois Nature Preserves Commission and the Department are responsible for the Illinois Nature Preserves System, which provides for dedication and protection of nature preserves under State law. Accurate and detailed information about natural areas is needed to fulfill these protection goals.

There might be some question about the need for a large-scale, detailed natural area survey, but the Department of Conservation foresaw the potential benefits. Now that it has been completed, the value of a comprehensive effort is even more apparent.

One question is, *"We already know of more natural areas than we can possibly save, so why look for more?"* The answer is that, given limited resources for preserving areas, one should be certain that time and money are spent on the most important areas.

Another argument is, *"We already know the most important areas--they are obvious without a detailed inventory."* This did not prove to be the case in Illinois. Prior to the Natural Areas Inventory, information about natural areas had been compiled by the Nature Preserves Commission, Natural History Survey, and Department of Conservation. So little is left of

Illinois' original natural communities that it might appear that the significant natural areas would have been readily apparent and would already have been found, but 61% of the 610 sites with high quality natural communities that were identified by the Inventory were previously unknown to the Department of Conservation and the Nature Preserves Commission. These new areas include not only small, obscure areas but large forests, wetlands, and other communities. In terms of acreage, these newly discovered areas include 42% of the high quality natural communities identified by the Inventory.

"But how many of these new areas could have been found by just compiling the available information and not doing original research?" The Inventory compiled information available from people, agencies, and the literature, as well as doing its own surveys, so it is possible to show how many significant natural features would have been found if the project had stopped after compiling existing information. The project would have been able to identify with certainty 29% of the areas with high quality natural communities. Information that would have required further checks to substantiate would have been available for 14% of the areas, and 57% probably would have been overlooked.

In addition to finding as many significant areas as possible, the Inventory acquired accurate and uniform basic information about the sites. The staff visited all areas with relatively undisturbed terrestrial or wetland communities, and they checked sites for endangered species if current and adequate information was not available. If the project had relied solely on information from secondary sources, the amount of data that could have been collected in a uniform manner for all areas would have been very limited, and nonqualifying areas would have been included by mistake. The Inventory had a trained and coordinated staff of ecologists to collect and evaluate information, rather than relying on other sources such as publications that might be out-of-date. An analysis of how much accuracy and completeness would have been sacrificed by omitting fieldwork is presented in Section 24.

An inventory brings information together into one information system, so that areas can be readily compared and evaluated. Requests for

information from planning agencies and for environmental impact analyses can be answered with less effort. The Department of Conservation reviews the potential impact of 10 or more proposals for development of water areas, highway corridors, and other sites in a typical week. Unnecessary conflicts with developers are avoided by planning ahead. Less time is spent responding to emergencies, and the time that is saved can be used to protect areas.

A comprehensive inventory provides information needed to determine which natural areas are most significant and needed to complete a nature preserves system. A plan based on a solid background of information is more likely to be accepted by the people of Illinois and by the owners and managers of natural areas. Time and money for a systematic inventory are well spent to assure that the right areas are given priority for preservation. It costs money to inventory a natural area, but it costs even more money to negotiate preservation or to acquire an area, and management costs continue indefinitely. Dedicating an area to preservation as its highest and best use is a big commitment to the future, and public agencies have an obligation to make correct decisions about which areas should be preserved.

The Illinois Natural Areas Inventory will continue to be updated. However, as much information as possible was collected in an initial effort instead of relying on gradual accumulation of information as it becomes available. Otherwise, doubt would continue about the relative value of areas because significant sites might have been overlooked. In the meantime, natural areas would continue to be destroyed. Threats of destruction were identified for half of the natural areas, and certainly more are threatened with disturbances unknown to the Inventory. The impact of development on the remaining natural areas is described in Section 26.

Section 3.
BASIC ORGANIZATION OF THE INVENTORY

Inventory Requirements and Guidelines

Definition of a natural area

A natural area was defined as a tract of land or water with a natural configuration or sufficient buffer land to insure its potential for protection and proper management, that:

(1) contains relatively undisturbed terrestrial or wetland natural communities, which have fauna and flora that reflect as nearly as possible the conditions at the time of settlement,

(2) is a habitat with an endangered animal or plant,

(3) is a habitat with relict species,

(4) has an outstanding geologic feature,

(5) is used and managed as a nature preserve or as a natural area by a school,

(6) has a unique natural feature, or

(7) is an outstanding natural aquatic area.

The definition was refined and further defined in the natural area categories discussed in Section 4.

Sources of information

As specified by the Department of Conservation, various kinds of natural areas were surveyed in different manners. Information about areas with relatively undisturbed natural communities and with relict species was gathered from field surveys. The inventory of endangered species relied mainly on existing records, but species were checked in the field when necessary and practical. Many sites with endangered species were discovered through other phases of fieldwork. The inventory of geologic areas was compiled by the Illinois State Geological Survey. The inventory of lakes and streams relied on recommendations from the Illinois Natural History Survey. The survey of school natural areas was conducted by mailed questionnaires and review of publications.

Some basic guidelines

Acreage standards.--Minimum size standards were defined for areas with high quality natural communities. Such areas were included if they were 20 acres or larger, with the following exceptions: (1) If a particular type of natural community is not normally as large as 20 acres (such as seeps and glades), then the 20-acre minimum did not apply. (2) Natural prairie remnants as small as one-quarter acre were inventoried. (3) An area smaller than 20 acres was recognized if it was the least disturbed remnant of a particular kind of community. Minimum acreages were not defined for sites other than the ones with high quality communities. Geologic areas, habitats with endangered or relict species, and school natural areas could be any size that adequately represented the significant feature and provided potential for protection of the area.

Degree of disturbance.--Outstanding representatives of natural communities were selected on the basis of relative lack of disturbance, but disturbed areas could qualify in the other natural area categories. Although the term *natural area* was applied to any site listed by the Inventory, many are not undisturbed sites.

Ownership and preservation status.--All of Illinois was surveyed, and areas were inventoried without regard to the type of ownership or whether an area was preserved. Information was collected about all natural areas to provide a complete base of information.

Structure of the Inventory

The project consisted of two parts: (1) surveys to find and to collect information about natural areas, and (2) an information system to store, retrieve, and analyze the data. The information system consists of maps, files, and a computer system that is described in an accompanying report.

Surveys

Surveys of different categories were often conducted at the same time. Fieldwork was conducted in the following surveys:

Main Survey (for relatively undisturbed natural communities)

Railroad Prairie Survey

Cemetery Prairie and Savanna Survey

Endangered Species Survey

Relict Species Survey

The surveys were usually conducted within individual counties, but it was sometimes more efficient to ignore county boundaries, as in the railroad prairie survey and searches for hill prairies along rivers.

Each survey was a process of selecting potential natural areas, then determining which ones were significant. Each successive stage examined the remaining candidates in greater detail. The survey stages were as follows:

Compiling available information
- Gathering background material
- Contacting people and agencies
- Reviewing literature

Examining maps and aerial photographs

Aerial survey

Initial ground survey

Final field survey

The inventories of geologic areas, aquatic areas, and school natural areas relied on compiling available information, so the last four survey stages usually were not conducted for these areas.

Offices and staff

The main office at the University of Illinois in Urbana housed the project director and usually two senior assistants, a secretary, and technical assistants. The state was divided into five districts with one or two natural area ecologists in each district. Most of the ecologists had a Master's degree in botany, zoology, or forest ecology. Ten field assistants were employed during the summer of 1976, and there were eight summer assistants in 1977. Most of the field assistants had recently completed or were enrolled in graduate studies in a biological science. Additional part-time staff was provided as needed by the Natural Land Institute's office in Rockford.

Schedule

Pilot studies began in March 1975, and natural area ecologists were hired and began a 3-month training session in July. The first stages of the Main Survey (compiling available information, examining maps and aerial photos, aerial surveys, and initial ground surveys) began in September 1975 and continued until June 1976. The final field survey of areas found during the first year's work was completed in the summer of 1976, and the Main Survey of the remainder of the state was completed during the following year. More training sessions and pilot studies were conducted as new parts of the project were started. The preliminary stages of the Railroad Prairie Survey were completed in late 1975, and the final field survey of railroad prairies was done in the summer of 1976. Cemeteries were surveyed to find prairie and savanna remnants from August to October 1976. Most work on endangered and relict species was completed in 1977.

Basic Principles

To the greatest extent possible within limitations of time and money and within the guidelines set by the Department of Conservation, the Inventory conducted a thorough inventory of Illinois' natural areas. Making sure that areas were not overlooked was emphasized as much as describing and evaluating the significant sites.

This project differed from many other natural area surveys in that the staff devoted much effort to searches for relatively undisturbed natural communities. Many techniques were developed for finding and evaluating high quality natural communities, and a large part of this report is devoted to these topics. This does not mean that information from existing sources was ignored or that the elements of natural diversity that occur in disturbed areas were slighted. A wealth of information was compiled from the work of others, including over 1,400 published references to biologically significant areas. Although the degree of disturbance was the criterion for identifying one category of natural area, 60% of the natural areas have significant features other than lack of disturbance.

Instead of choosing natural areas and then deciding why they were important, the project developed a list of significant features and then found occurrences of these features. A further step was taken by drawing natural area boundaries around the significant features to include the natural diversity of the site and to provide potential for protection of the features. If one significant feature occurred with another, then both were included in the same natural area, but each significant feature kept its separate identity and remained an independent reason for recognizing the site.

Information Requirements

The Department of Conservation requested certain items of information about each area, which were refined into the following data items. A description of each item and the source of the data are described in Section 13 and Appendix 17. Not every item was appropriate or was collected for every category of natural area.

Basic information

County

Name of area

Significant feature.--The reason why a natural area is significant

Exceptional feature.--A feature that adds to the value of a natural area

Preservation value score

Evaluator

Date of evaluation

Location

Legal location.--Township, Range, Principal Meridian, section and quarter-quarter section

Access

Topographic quadrangle

Stream system

Specific stream drainage

Legislative district

Municipality

Governor's Region

Natural characteristics

Altitude.--Maximum and minimum

Topography.--Physiographic unit, major topographic feature, and individual topographic feature

Geologic formation

Soil association.--Statewide classification and county classification

Natural community classification.--Natural community, community class, and Natural Division and Section

Rarity index.--For each natural community

Diversity index

Natural quality.--Acreage of each natural community in each natural quality grade; description of natural quality

Total acreage of natural area

Society of American Foresters' forest cover type.--For each natural community, where applicable

Plant community.--For each natural community

Legal status and use

Ownership type

Number of ownerships

Owner or custodian

Use of natural area

Use of surrounding land

Nearest Standard Metropolitan Statistical Area (SMSA)

Distance to nearest SMSA

Number of nearby universities and colleges

Name of nearest university or college

Number of nearby Department of Conservation facilities

Land management facility

Manageability

Management problem description

Zoning of area

Zoning of surrounding land

Regional planning commission

Forest preserve district

Conservation district

Legal status and use, cont.

Preservation status

Attitude of owner or custodian toward preservation

Threat of destruction

Discussion of preservation values

Supplemental materials

Species lists

Vegetation sampling data

Topographic map with boundaries

Aerial photo with overlays

Additional notes and other materials

Literature citations

PART II
CONCEPTS AND TERMS

Part II explains the basic terminology of the Inventory. The categories of natural areas are described, as are the terms used to describe and classify natural areas. A clear understanding of the concepts and terms in the following four sections is necessary to understand the rest of this report.

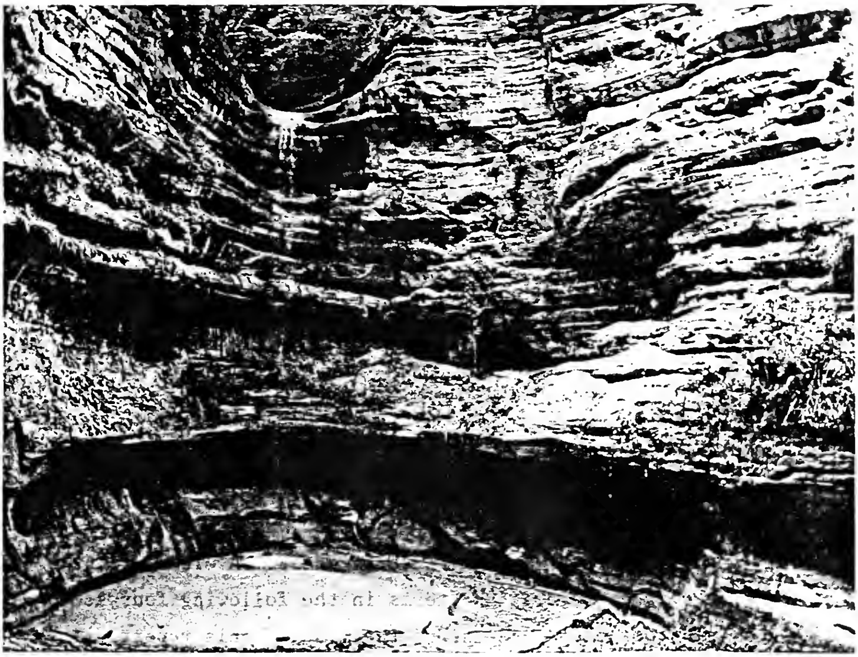

Plate 3. *A canyon in Starved Rock State Park. This area on the Illinois River qualified as a natural area under five categories. It has high quality natural communities, habitats with endangered and threatened species, and assemblages of relict species. The park contains outstanding bedrock outcrops, and portions are dedicated as an Illinois Nature Preserve.*

Section 4.
NATURAL AREA CATEGORIES

Introduction

The Inventory recognized seven kinds of natural areas. The seven categories, each defined by its significant features, are in Table 1. The natural area categories are listed below, and they are further defined in Part IV.

Table 1. Natural area categories and significant features.

Natural area category		Significant feature
I.	Ecological area	High quality terrestrial or wetland natural community
II.	Endangered species habitat	Habitat with endangered species
III.	Relict species habitat	Habitat with relict species
IV.	Geologic area	Outstanding geologic feature
V.	Natural study area	Nature preserve or land that is managed and used for natural science studies
VI.	Unique natural area	Unique natural feature
VII.	Aquatic area	Outstanding aquatic feature

Summary of Categories

Category I: High quality terrestrial or wetland natural communities

These areas have natural communities that are relatively undisturbed, so that they reflect as nearly as possible the natural condition at the time of settlement in the early 1800's. Areas in this category were chosen because of their high natural quality, as explained in Appendix 22.

Category II: Habitats with endangered species

These sites have vertebrate animals or vascular plants that are in danger of extirpation from Illinois.

Category III: Habitats with relict species

Sites were recognized as natural areas if they have outstanding assemblages of plants that are relicts of a past climatic period.

Category IV: Outstanding geologic features

Localities that are outstanding representatives of the state's geologic diversity were listed as geologic areas. In addition to natural features, artificial sites such as abandoned quarries could qualify as geologic areas.

Category V: Nature preserves or lands that are managed and used for natural science studies

Lands that are specially managed and used as natural areas for teaching and research or as nature preserves were included in this category, even though the natural communities might have been disturbed. This category includes areas such as dedicated Illinois Nature Preserves and Federal Research Natural Areas, as well as areas maintained by schools.

Category VI: Unique natural features

A few significant natural areas did not fit into any of the above categories. These are sites of unique natural features, which are often small areas with unusual floristic, faunistic, or ecological features. Examples include (1) a cave with an outstanding invertebrate fauna, (2) a large bat hibernaculum, and (3) a cliff habitat that has an unusual assemblage of plants that cannot be considered endangered or relict species.

Category VII: Outstanding aquatic features

Some streams and lakes were listed as natural areas because they are relatively unpolluted and natural habitats for native aquatic life. These areas are distinct from Category I wetlands because the water quality and the fauna were the bases for recognizing the area; in contrast, the undisturbed character of the vegetation was the primary consideration in Category I wetlands.

Section 5.

NATURAL AREA BOUNDARIES, LAND CONDITION CLASSES, AND FEATURES

Introduction and Summary

According to the Illinois Department of Conservation's definition, a natural area must be:

(1) a tract of land or water, with a *natural configuration* or sufficient buffer land to insure its potential for *protection and proper management*, that

(2) meets one or more of the criteria (described in Section 4) for recognition as a natural area, such as a relatively undisturbed natural community or an outstanding geologic feature.

The first part of the definition states that a natural area should have a natural configuration. That is, the boundaries of a natural area should coincide with the boundaries of natural features such as the edge of a forest, which may or may not be the same as artificial lines or boundaries such as a road. To insure that it has potential for protection and proper management, a natural area may include land that has little natural value but is needed as buffer. Accordingly, a natural area may be divided into two land condition classes: *natural land* and *buffer land*.

The second part of the definition requires that a natural area must have at least one *significant feature*, which is the reason for recognizing a natural area. Other important features besides the significant feature may be present in a natural area.

In summary, a natural area can be described according to its land condition classes and features, outlined as follows:

- Land condition classes
  - Natural land
  - Buffer land
- Features
  - Significant features
  - Exceptional features
  - Notable features

Artificial disturbance features
Natural disturbance features

The concept of natural quality and grades (Section 7) is important in the discussion that follows.

Land Condition Classes

Natural land

The part of a natural area that is relatively undisturbed is termed *natural land*. It is defined according to natural quality, and it includes Grade A, B, and C natural communities. Although the boundaries of natural land and the significant feature may coincide, natural land often extends beyond the significant feature. When natural land does extend beyond the significant feature, it consists of Grade C natural communities or Grade A and B stands that are too small to qualify as significant features.

Buffer land

This consists of land within the natural area boundaries that is not natural land. Buffer land consists of Grade D or E natural communities that are included in the natural area to insure potential for protection of the significant feature.

Applicability of the land condition classification

The land condition classes are mapping units based on natural quality. The classes were mapped for Category I natural areas and Illinois Nature Preserves. For other kinds of natural areas, the only parts of the natural area that were mapped are the features described in the remainder of this section.

Boundaries

Guidelines for determining the boundaries of the natural area, natural land, buffer land, and significant features are detailed in Appendix 16. The rules for determining the boundaries of a natural area are summarized as follows:

(1) Boundaries should be conservative, but adequate to include the significant features and to provide potential for protection of the area.

(2) Natural area boundaries should follow the boundaries of natural features if possible.

(3) Acquisition factors such as access and monetary value of the land should not be considered.

(4) Boundaries should not be drawn arbitrarily.

Features

Any part or characteristic of a natural area is a *feature*. Although components such as topographic features and natural communities are also features of an area, this discussion is limited to the basic classes of features that were introduced above: significant features, exceptional features, notable features, artificial disturbance features, and natural disturbance features.

Significant features

A feature that allows a site to qualify as a natural area of statewide significance is a *significant feature*. Table 1 lists the kind of significant feature for each natural area category, and Table 2 gives examples of significant features. A natural area must have at least one significant feature. The boundaries of a significant feature may coincide with the boundaries of a natural area, but the natural area often extends beyond the significant feature. For example, a tract may consist of a steep hillside with a mature second growth forest (not a significant feature) and a series of one-quarter to 2-acre Grade A hill prairies (the significant features). The mature second growth forest is designated as natural land; but, in the absence of the hill prairies, the hillside would not be outstanding and the tract would not qualify as a natural area.

Exceptional features

An *exceptional feature* is a feature that increases the preservation value of a natural area but is not important enough to be the reason for identifying a natural area. After a site was recognized as a natural area because of a significant feature, then the presence of exceptional features on the tract was recorded. A summary of exceptional features is in Table 2.

Table 2. Comparison of significant features, exceptional features, and notable features.

Cat.	Significant feature	Exceptional feature	Notable feature
I.	Area with Grade A or B natural communities that equals or exceeds the minimum acreage (usually ¼ acre for prairies, and 20 acres for other communities).	Area with Grade A or B natural communities that (1) is smaller than the minimum acreage, and (2) does not qualify as the only or least disturbed example, but (3) is large enough to still be considered a stand (generally at least 5 acres for most natural communities, but less than ¼ acre for prairies and similar communities).	Individual or small group of old growth trees.
	Area with Grade A or B natural communities that is smaller than the minimum acreage, but that qualifies as the only example or the least disturbed example of a particular community.		Prairie plants only; not a natural prairie community.
	Area with Grade C natural communities (regardless of size) that qualifies as the only example or least disturbed example of a particular community.		
II.	Habitat with a species that is in danger of extirpation from Illinois.	Habitat with a species that is not currently endangered, but is very rare or local in Illinois.	Habitat with a rare or unusual species.
III.	Habitat with an assemblage of relict plants, of statewide significance.	Habitat with an assemblage of relict plants, of regional significance.	
IV.	Outstanding geologic feature, of statewide significance.	Any bedrock or regolith exposure. Cave, fossil bed, etc.	
V.	Land that is managed and used as a natural area for teaching and research, or land that is dedicated as a nature preserve.		
VI.	Unique natural feature, of statewide significance.	Unusual soil type or other unusual natural feature that is of regional significance. Heronry. Historic site or archeological site.	Unusual natural feature that is of minor, local significance.
VII.	Outstanding lake or stream, of statewide significance.	Any aquatic feature, except ephemeral features.	Ephemeral aquatic feature.

Significant features and exceptional features are equivalent to *elements of natural diversity* in the State Natural Heritage Programs of The Nature Conservancy. The Heritage Programs make a distinction between *elements* and *element occurrences*: for example, the bald eagle is an element of our natural diversity, and an actual nesting site for bald eagles is an element occurrence (see Jenkins, 1978). Although the distinction between elements and element occurrences is important, the Illinois Natural Areas Inventory usually applied the terms *significant feature* and *exceptional feature* to both the abstract concept and the real occurrence. The meaning is usually clear by the context in which the terms are used.

Notable features

A *notable feature* is any feature of a natural area that is less important than a significant feature or an exceptional feature. A notable feature does not increase the preservation value of a natural area, and recording the presence of a notable feature was optional. The summary of notable features in Table 2 is incomplete because many features may be listed as notable.

Artificial disturbance features

Cultural features such as roads, trails, fences, buildings, and power lines are *artificial disturbance features*. These are local disturbances, as opposed to broad disturbances that lower the natural quality of a natural community. For example, a narrow pipeline right-of-way is a disturbance feature, but a cultivated field is a Grade E area, not a local disturbance feature. Similarly, a drainage ditch in a marsh is a disturbance feature; but the entire wetland is not a disturbance feature, even though the ditch may lower the natural quality of the marsh.

Natural disturbance features

Examples of *natural disturbance features* are (1) a stand of trees killed or damaged by a windstorm, fire, insects, or disease, (2) an area flooded by a beaver dam, and (3) a stand of shrubs invading a prairie. These are considered natural disturbance features because they are the results of natural agents, even though the disturbances may be attributed indirectly to human activities. In the above examples, the fire may have been started by a person; the disease, insects, and beavers may have been

introduced by humans; and the woody invasion may be the result of unnatural fire suppression. However, since the disturbances result from natural processes instead of direct human activities, they are considered natural disturbance features.

Section 6.
NATURAL COMMUNITY CLASSIFICATION

Summary

The Inventory's classification of natural communities was a basis for identifying Category I significant features, and it was used to classify all natural areas. The classification system is detailed in Appendix 30 and is briefly reviewed in the following paragraphs.

The natural community classification uses the concept of the *Natural Divisions of Illinois* (Schwegman, et al., 1973), which recognizes regions of the state on the basis of topography, glacial history, bedrock, soils, and the distribution of native plants and animals. A map and a brief description of the Natural Divisions are in Appendix 30. The Inventory's classification further subdivides the Natural Divisions and Sections into nine community classes:

Forest
Prairie
Savanna
Wetland
Lake and Pond
Stream
Primary
Cave
Cultural

The smallest unit in the classification is the *natural community*, which is a subdivision of a community class. A natural community is a group of organisms interrelated with each other and their environment. Although a natural community might be defined at any scale, it was used as the smallest unit of land or water that could be mapped on large-scale (1:7,920) aerial photos.

Natural communities were classified and named by considering a variety of natural features and choosing the dominant features that distinguish one community from the others. One or two important descriptive features are usually included as modifiers in the natural community name, as in *dry sand savanna*.

There are 93 different kinds of natural communities (Table 38), including eight cultural communities. Each Natural Division and Section has its own, distinct set of natural communities, and the name of the Natural Division and Section is part of the natural community name. For example, a *dry-mesic prairie of the Springfield Section of the Grand Prairie Division* is a community distinct from a *dry-mesic prairie of the Western Section of the Grand Prairie Division*. For practical reasons, the shortened name, *dry-mesic prairie*, is used unless a distinction needs to be made between communities in different Natural Divisions or Sections.

Section 7.
NATURAL QUALITY

Summary

Natural quality is defined as a measure of the evidence of disturbance to a natural community. The Inventory used the relative lack of disturbance to identify Category I significant features, and described the degree of disturbance of all communities in all natural areas. A system of letter grades was developed to express degrees of natural quality. The grading system is based on degree of disturbance, alone: other factors such as acreage and the presence of endangered species were not considered when determining natural quality. Although these other factors are important for determining the overall preservation value of a natural area, they were kept separate so that natural quality described only the degree of disturbance.

The grading system provides terms for describing the relative amount of successional instability or change in a community's natural diversity, species composition, and structure due to disturbance. The grades are summarized as follows:

Grade A: Relatively stable or undisturbed communities. Example: Old growth, ungrazed forest.

Grade B: Late successional or lightly disturbed communities. Example: Old growth forest that was selectively logged 5 years ago.

Grade C: Mid-successional or moderately to heavily disturbed communities. Example: Young to mature second growth forest.

Grade D: Early successional or severely disturbed communities. Example: Severely grazed forest of any age.

Grade E: Very early successional or very severely disturbed communities. Example: Cropland.

The natural quality grades are described in more detail in Appendix 22. Some procedures for evaluating and describing disturbances are in Appendix 21.

PART III
METHODS

This part of the report describes the stages of the inventory and the items of information collected for each area.

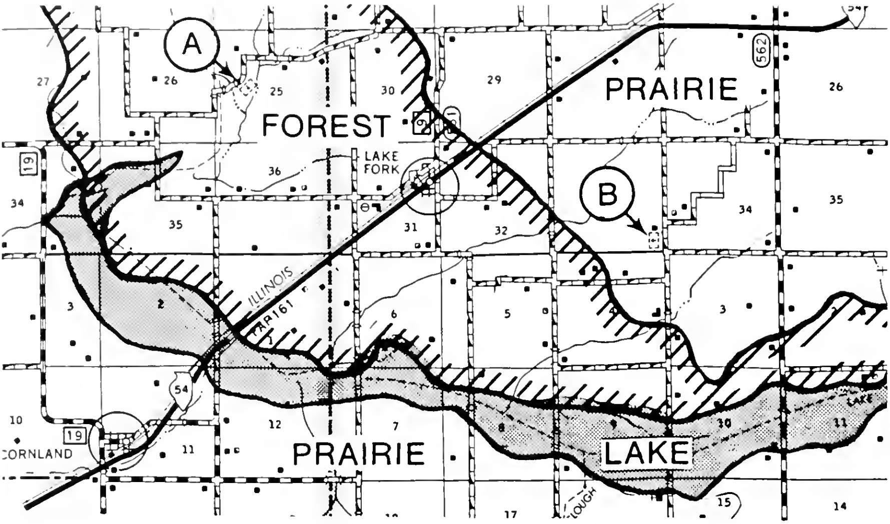

Plate 4. *A section of the* Presettlement Vegetation Atlas of Illinois. *The maps were used to select cemeteries to survey for prairie remnants. For example, the cemetery at* A *is more than a mile inside the forest, and has no potential for prairie vegetation. The cemetery labeled* B *is on prairie soil, one-half mile beyond the limits of the forest. The rear of this cemetery has a remnant of native prairie vegetation.*

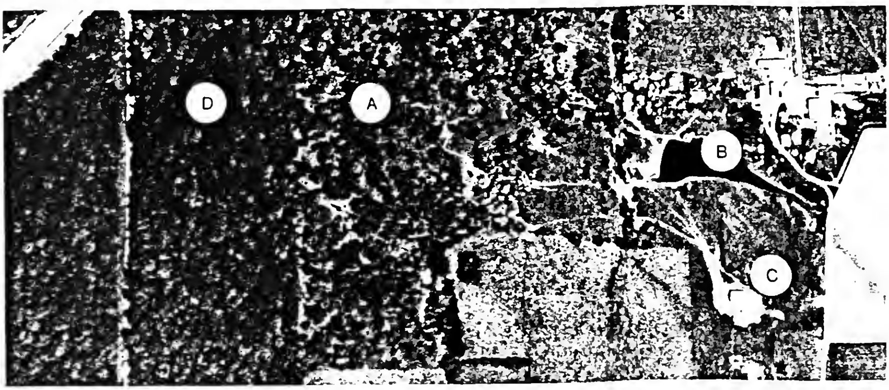

Plate 5. *An example of an aerial photo used to select potential natural areas. The tract labeled* A *shows evidence of grazing damage: the trees are widely scattered, and whitish livestock trails extend into the trees from a stock pond* (B) *and a barn* (C). *The timber stand labeled* D *has a dense, even canopy of large-crowned trees, indicating an old, undisturbed forest.*

Section 8.
COMPILING AVAILABLE INFORMATION

Purpose

Information was gathered from sources such as publications to (1) identify natural areas, (2) compile resources that would aid the search for areas, and (3) collect information that would help describe and evaluate areas.

Procedure

Gathering background material

This involved obtaining soil reports, maps, unpublished reports, and similar information, usually related to specific counties or areas. Much information was from the Illinois Nature Preserves Commission, Department of Conservation, and Natural History Survey. Work in cooperation with the Illinois Endangered Species Project to find records of endangered species in herbaria and museum collections is described in Section 17.

Contacting people and agencies

As part of the survey of each county, the fieldworkers asked the following professionals for information about natural areas: district foresters for the Department of Conservation, district conservationists for the Soil Conservation Service, and county executive directors for the Agricultural Stabilization and Conservation Service. The staffs of forest preserve districts and conservation districts were also contacted. Enquiries often led to other citizens who knew about natural areas in a particular region. Other people with known interests in natural areas were contacted, especially faculty members at colleges and universities.

General publicity

The Inventory was widely publicized to solicit information about natural areas. The Department of Conservation taped five interviews during various phases of the project and distributed the tapes to about 80 radio stations. There were two live radio programs, a television

presentation, four statewide news releases, and several articles in newsletters and local newspapers. The staff presented 27 talks, attended by an estimated total of 2,000 people, at conferences, universities, and meetings throughout Illinois. Schwegman (1977*a*, 1977*b*) and Madany (1977) wrote feature articles about the project.

Literature review

The literature review is listed here as a part of the process of compiling available information, but it was such a large effort that it is discussed separately in Section 23.

Results

Compiling background information was a necessary preparation for the rest of the inventory, and it revealed some previously unrecognized natural areas. Because many Inventory staff members were already familiar with the files of the Department of Conservation, Natural History Survey, and Nature Preserves Commission, the amount of new information gained from these files cannot be determined for certain. However, collecting and organizing these resources provided a sound background for further work. The amount of information gained from various conservation-related agencies varied according to the personal knowledge and interests of the individual contacted. Faculty members at colleges and universities and amateur naturalists were the most valuable sources of information about potential natural areas in many counties. General publicity efforts through the news media and presentations to groups yielded very little new information about significant natural areas, but it did make more people aware of the Illinois Nature Preserves System. The effectiveness of compiling existing information for finding and screening potential natural areas is discussed in relation to other stages of the inventory in Section 24.

Section 9.
EXAMINING MAPS AND AERIAL PHOTOGRAPHS

Introduction

Maps and aerial photos of each county were systematically examined to (1) select potential natural areas, (2) determine what land had no significant potential for natural areas, and (3) map, describe, classify, and evaluate the identified natural areas.

Topographic maps were the basic maps used by the Inventory. There are many useful sources of information about the use of topographic maps, including publications by the U. S. Geological Survey (1969), Beveridge, et al. (1957), Cote (1967), and the U. S. Department of the Army (1969). Atlases by DeBruin (1970) and Richason (1972) provide excellent illustrations of representative geologic, vegetation, and cultural features on topographic maps.

There are also many useful references about aerial photo interpretation. Books by Strandberg (1967), Avery (1968), and Way (1973) are among the best sources of information about using aerial photos; and Avery (1969) provided a practical discussion of interpreting aerial photos of forested land. The following atlases have examples and descriptions of geologic features, vegetation patterns, and cultural features that are relevant to Illinois: Ray (1960), Wanless (1969), Richason (1972), and Baker and Dill (1970, 1972).

Map Resources

Topographic maps

The project used 7.5-minute U. S. Geological Survey quadrangles with forest overprint when available, but only the 15-minute series is available for about 40% of Illinois. The 15-minute maps were studied in addition to the 7.5-minute maps when both were available, because many of the 15-minute maps date from 1910-1940 and they show old clearings,

homesites, roads, and other disturbances that may no longer be shown on the 7.5-minute series.

Highway maps

County highway maps produced by the Illinois Department of Transportation proved useful for general planning, summaries, and aerial navigation. The maps are available at the scale of 1 inch equals 2 miles, and a bound atlas of smaller-scale copies of these maps is commercially available.

Presettlement Vegetation Atlas of Illinois

A set of county maps showing presettlement vegetation based on the original Public Land Survey was used to find areas with potential for prairie vegetation. The atlas is described in Appendix 19.

Soil maps

The soils of almost every county have been mapped. The county soil maps vary in age, quality, and detail. The general soil association maps were most helpful for finding unusual kinds of soils. A small-scale state soil association map by Fehrenbacher, et al. (1967) was used for a uniform, statewide classification.

Geologic maps

The *Geologic Map of Illinois* by Willman and others (1967) was effective at 1:500,000 scale for much of the work. Detailed surficial geologic maps for most areas of Illinois that have bedrock outcrops are available in Master's theses and Illinois State Geological Survey reports and files.

Aerial Photographs and High-altitude Images

The Inventory relied on relatively low-altitude, conventional black and white aerial photographs as one means to find, evaluate, describe, map, and classify natural areas. This section describes the aerial photos and briefly discusses the advantages and disadvantages of the various kinds of aerial photos and other remotely sensed images. All kinds of terrain imagery, from low-altitude aerial photos to satellite "images" (which are not photographs) are classified as remote sensing.

Sabins (1978) presented a comprehensive and recent analysis of remote sensing techniques.

ASCS aerial photographs

The Agricultural Stabilization and Conservation Service (ASCS) of the U. S. Department of Agriculture periodically produces aerial photographs of every Illinois county. The land is photographed during the growing season on panchromatic black and white film, with a minus-blue filter. The negatives are 1:20,000 scale, and the photos overlap to allow stereo viewing. Contact prints from the most recent flights are on file at the state ASCS office in Springfield; the ASCS office in each county has a set of enlargements at the scale of 1:7,920 (8 inches equals 1 mile, or 1 square inch equals 10 acres).

The ASCS enlargements are of good quality and were suitable for the Inventory's needs. Many vegetation and cultural features are easy to recognize, and resolution is adequate. Ground resolution is usually 2 to 3 feet (U. S. Department of Agriculture, Economic Research Service, 1969), and the smallest object that can be identified without some clue such as its relation to its environment is about five times the ground resolution (Strandberg, 1967). For example, cattle can sometimes be identified on ASCS photos as light-toned, rectangular features at feed bunks and watering tanks. Linear features and objects that contrast with their surroundings are most readily distinguishable. For example, the faint pattern of lines in a field plowed several years ago is often visible, and the crown of a solitary tree is distinguishable. Under unusual circumstances even the painted center stripe on a highway or large electrical transmission cables can be seen.

ASCS photographs are taken of each county about every 7 years, and the earliest photos of most counties were taken between 1938 and 1941. These earlier photos are valuable because they show how an area appeared in the past. The county ASCS offices keep enlargements from at least one previous flight, and university libraries receive the outdated contact prints.

Other aerial photographs

Other kinds of aerial photos are available for parts of Illinois, but only ASCS aerial photos were used by the Inventory, mainly because the resolution of other photos is not fine enough or the photos are not widely available. Infrared color photos (also known as false-color infrared) would have been preferred instead of ASCS panchromatic photos, because the infrared film provides better contrast among vegetation types and better detection of wetlands. However, infrared photos are not easily obtained: they have been taken of only small parts of Illinois for specific projects by agencies such as the U. S. Army Corps of Engineers. The state has been photographed from high-altitude military aircraft and spacecraft, but the coverage is incomplete, the scales vary, and ground resolution is much less than for low-altitude aerial photos. Other low-altitude black and white photos, similar to ASCS photos, are available from agencies such as the U. S. Geological Survey. However, coverage of the state is incomplete, the photos are not easily obtained, and most are winter photography, which greatly limits vegetation analysis.

Landsat images

Interest is developing in satellite imagery as a means of studying natural resources since the launching of the ERTS-1 satellite in 1972. Two more satellites (now named *Landsat*) have been launched, and the National Aeronautics and Space Administration has supported research to evaluate uses of Landsat imagery. Williams and Carter (1976) edited a collection of papers describing such Landsat research in many disciplines, including vegetation mapping. Relatively nontechnical publications that are helpful for learning about Landsat imagery are by Dickson (1977), Short, et al. (1976), and Lineback (1975). The Illinois Environmental Protection Agency (1978) presented a basic explanation of Landsat images and their use.

Landsat has a low resolving power, which limits its usefulness for natural area inventories. Relatively small or narrow features with great contrast (such as highways) can sometimes be detected, but processed images usually have a ground resolution between 200 and 250 meters. The recently launched Landsat 3 reportedly has better resolving

power than the earlier satellites, but even these new images would not have been suitable because the Inventory workers needed to see thin grazing trails and the gaps in the forest canopy caused by the removal of single trees. In a test of ERTS-1 imagery, Fentress and Frye (1975) were able to map land in a Texas county with 10 land use or cover classes, portraying every fifth picture element (57 meters by 79 meters), with 82% accuracy. In contrast, the Inventory staff did not map large areas, but studied areas smaller than one picture element, recognized a practically unlimited number of land use and vegetation cover combinations, and strived for 100% accuracy.

Landsat images are useful for regional surveys, broad classifications, small-scale maps, and detection of large, faint surface features. They allow a quick, general overview of an area, but they cannot replace topographic maps and large-scale aerial photos for finding and describing natural areas.

The satellite images have a feature that might be used to an advantage: Landsat records the sunlight reflected from the earth in four spectral bands. Different kinds of earth, water, and vegetation reflect sunlight differently, so some features are more apparent on one spectral band than on another. By processing images in certain ways, certain vegetation types are most vividly portrayed. Despite problems with low resolution, Landsat images do have potential for determining unusual habitats and natural communities of limited extent. By choosing the correct season, light wavelengths, and processing, it might be possible to find a unique spectral reflectance, or "signature" to identify prairies. Although there is much potential for study in this field, the Inventory found no need for detailed experimentation because standard map and aerial photo interpretation techniques worked well.

Procedure and Results

Examination of maps and aerial photos was conducted within individual counties and proceeded by legal township and section. The procedures for detecting natural areas and disturbances on maps and photos are discussed in Appendix 21. Areas that had potential as significant natural

areas were outlined and numbered on topographic maps. Brief notes about the potential natural areas as well as the disturbed areas were recorded on the maps and on forms.

After the current ASCS enlargements were reviewed, the potential Category I natural areas were examined on the oldest available ASCS photos. The old photos (often as early as 1938) showed previous disturbances not apparent on the newer photos, and they helped the investigator to interpret apparent disturbances detected on the newer photos.

The 1:7,920 scale aerial photo enlargements available in ASCS offices were used for the main screening instead of contact prints because significant details can be overlooked on contact prints. Although the enlargements have no more detail than the contact prints, studying the enlargements is less tedious and causes less fatigue and eyestrain. Other advantages of using enlargements were: (1) the photos were the most recent available, (2) acreages of some tracts were marked by the ASCS on the photos, and (3) using the aerial photos in the county ASCS office provided an opportunity to talk to local people and to check areas during the examination procedure.

The map and aerial photo examination required from 3 to 5 days for a typical county, and usually 20 to 40 potential natural areas were found. In a few counties the procedure required less than a day, and no areas were found. A few counties with many wetlands required 2 or 3 weeks of study and resulted in over 100 sites to be checked.

Section 10.
AERIAL SURVEY

Purpose

The aerial survey was a means of (1) screening potential areas, (2) finding new areas, and (3) determining boundaries and characteristics of natural areas.

The aerial survey was an extension of the map and aerial photo examination stage. It provided a closer and more recent view than possible with maps and photos, and it allowed fieldworkers to reject many non-qualifying areas quickly, without completing the time-consuming initial ground survey. New areas were found and areas were studied in a detailed manner not possible with maps and photos. The aerial survey allowed a quick comparison and overview of many areas in a short time.

Procedure and Results

General techniques

Cessna 172 aircraft were used, which are single-engine, four-seat airplanes with high wings. Areas were viewed generally by flying as slowly as practical and safe (80 to 90 miles per hour), at 500 to 800 feet above the ground. Between sites, the planes could cruise at 110 to 120 miles per hour.

Before each flight, the sites to be checked were marked on a county highway map, and a flight plan was drawn on the map. Topographic maps with the sites outlined were also assembled, and Potential Natural Area Record Forms were put in order so that notes could be recorded for each area. The tracts usually were observed while circling each site from one to four times. Emphasis was placed on noting disturbances and special features, refining boundaries, and deciding whether the site still qualified as a potential natural area. Effective surveying from an airplane came with practice. Efficiency was gained by studying areas from an airplane that were already well known to the investigator. Knowing

the actual size of certain objects on the ground helped the surveyor to make other size estimates from the air.

Examples of techniques

Clues for identifying disturbances and natural communities are detailed in Appendices 20 and 21. Following are examples of how an airplane was used for finding natural areas.

Surveying from an airplane was useful for determining the boundaries of a natural area, which may differ from preliminary boundaries from aerial photos. The photos may not show some disturbances clearly, or the disturbances may have happened since the area was photographed. For instance, by circling 2,000 feet above a 1,000-acre swamp, fieldworkers were able to accurately and precisely map the extent of recent clearing and logging. In 14 minutes a task was accomplished that could not have been done as well on the ground, even with 2 days work by a two-person team.

Although most forested natural areas were found by examining aerial photos, the aerial survey was sometimes helpful for determining the exact boundaries of the highest quality stands of timber in large tracts of mature forest. The exact boundaries of the oldest stands of trees cannot always be delimited precisely from aerial photos if the forest in general is mature and has a natural structure. For example, there are many square miles of forest along the lower Kaskaskia River--mostly logged at various times and to different degrees, but with large, well formed trees because the land is so productive. The most promising tracts along the Kaskaskia were outlined from aerial photos, but the extent of some of the tracts was uncertain because the largest-crowned trees seemed to intergrade with younger stands. Bur oaks are common in the floodplain, growing on all but the wettest soil, and any tract of old growth bottomland timber in the region has large bur oaks. The task during the aerial survey was to select stands with large bur oaks, which are easy to distinguish from an airplane in the winter because they have thick, grayish limbs and twigs.

A technique similar to the preceding was developed during surveys over the Shawnee Hills. Old growth stands of dry upland forest could be

detected by spotting groups of very old post oaks. These trees have large crowns with gnarled, spreading limbs. They are easy to see from an airplane because the limbs are covered with greenish lichens. As with the bur oaks in the floodplain, the staff was able to find the old growth dry upland forests by searching for large, old post oaks after narrowing the possibilities by examining aerial photos.

Hill prairies occur along major river valleys on dry, exposed slopes, and they are highly visible from an airplane. Although hill prairies can be found by studying maps and aerial photos, it was not necessary to find every potential prairie before the aerial survey. Instead, the ecologists decided which sections of river valleys had potential for prairies, and flew along the bluffs marking the location of every hill prairie. The fieldworkers noted the ones that appeared to be relatively undisturbed and had potential as natural areas. Along some stretches of river bluff, color slides were taken of the prairies as an aid for finding small prairie openings on the ground.

Sand prairie remnants occur on plains along major rivers in central and northern Illinois. By examining aerial photos and soil maps it was possible to mark on topographic maps the uncultivated, grassy areas on sandy soil that were not obviously disturbed by grazing. The aerial survey was a systematic search of sand areas, examining the sites chosen by the map and photo examination and looking for small remnants that were not apparent on the photos. The disturbed areas were rejected, and color photos were taken of the largest sand prairies to aid the ground survey.

Natural seep communities occur along major rivers, so the aerial survey of seeps shared some basic techniques with the search for hill prairies. In the winter, seeps appear as prominent blackish patches, especially if the surrounding land is snow covered. (The ways in which snow enhances features observed from an airplane are discussed in Appendix 21.) Seeps sometimes are dark green because of horsetail colonies or emerald green because of water cress. By surveying after a light snowfall, it was possible to find the seeps along the 200-mile length of the middle Illinois River and lower Sangamon River in less than 5 hours.

Effectiveness

An average of 10 to 12 sites could be viewed in an hour from an airplane, which is the number that could be visited in 2 to 4 long working days on the ground. The potential natural areas in most counties could be surveyed from the air in 1 to 3 hours, but some counties required as many as 8 hours. Between 50% and 90% of the areas in an average county were eliminated during the aerial survey. In some counties, several new sites were found from the air. Although the aerial survey accounted for less than 5% of the survey budget, surveying without an airplane would have required seven to 10 times as much time and seven to 10 times as much money for fieldwork, and it would not have been possible to accomplish some tasks and find certain areas.

There were some difficulties with scheduling flights and with airsickness. The weather was suitable for flying only about half the time. Flights were often scheduled a week in advance, so a cancellation caused inconvenience and lost time, particularly since other activities had to be scheduled around the flight. Planes and pilots were hired from several different airports, and it took some effort to find pilots that provided reliable and skillful service. Circling in an airplane and studying areas intensely can cause airsickness, but the problem could be avoided by flying on calm days, circling gently, and taking airsickness drugs. The fieldworkers became less prone to sickness with experience.

In Lake, McHenry, and Cook counties, where there are many complexes of prairies and wetlands, an airplane was not as effective as desired because it was too fast. A helicopter was used for about 8 hours to survey these areas.

Section 11.
INITIAL GROUND SURVEY

Purpose

The purpose of the initial ground survey was to prepare for the final field survey by evaluating the sites selected during prior inventory stages. The initial ground survey also served to check the accuracy of the map and aerial photo examination and the aerial survey, and it was used to develop techniques for the final field survey.

Procedure

Initial ground surveys were conducted only for Category I areas. The surveys were completed during the dormant season so that the summer could be reserved for final field surveys. Other advantages to doing the initial ground survey in the late fall, the winter, and early spring were: (1) interspersing initial ground survey work with aerial surveys helped the fieldworkers develop their field evaluation techniques, (2) general surveys of forests were easiest when they were leafless, and (3) surveys of wetlands were quicker when they were frozen. Initial surveys were not made for potential endangered and relict species sites because these were usually small areas that required searching habitats during the spring and summer months.

During the initial ground survey the fieldworkers determined whether a potential natural area was significant. If an area was not significant, it was investigated only enough to record the reasons why it did not qualify. Significant areas were surveyed in more detail, to define the boundaries and locate features so that the final field survey could be planned.

Results

About two-thirds of the potential areas were rejected during the initial ground survey of a typical county. About 15% of the rejected sites were recorded as notable areas, of local significance.

Section 12.
FINAL FIELD SURVEY

Final evaluation, description, and classification of each natural area were completed during the final field survey. The information was recorded as described in the following paragraphs.

Main Data Form

Standard information was recorded on a Main Data Form, which is described in Section 13 and Appendix 17. If an area was not visited, then the Main Data Form was completed by using information available in the office. Some items on the Main Data Form (such as the legislative district) were not determined during the final field survey, but were completed later in the office.

Maps and Aerial Photographs

The boundaries of the natural area were drawn on a copy of a topographic map. If an area was an Illinois Nature Preserve or had a Category I significant feature, then the natural communities, natural quality, land condition classes, and other features were mapped with overlays on aerial photos. For other kinds of natural areas, topographic maps or sketch maps were used instead of aerial photos, and less detail was mapped.

Vegetation Sampling

Plant communities in Category I significant features were sampled to help determine the dominant species and to help assess the natural quality of the communities. In herbaceous communities, species frequency data were gathered from 20 or 30 one-quarter square meter circular quadrats in each plant community. Sampling techniques for forests were influenced by research by Lindsey, et al. (1958) and Ohmann (1973). Basal area was measured with a 3-basal area factor metric wedge prism (see Avery, 1967; Hovind and Rieck, 1970) at 20 points in each plant community.

Density of the overstory was recorded in 1-decimeter size classes in 0.025-hectare circular plots centered at each sampling point. Density of woody plants taller than 1 meter but less than 1 decimeter in diameter at 1.2 meters above the ground was recorded from a 0.001-hectare circular plot at every other sampling point. Absolute and relative values were calculated for the data. Initially, sampling points and plots were random, but later a systematic grid pattern was used to give a more even distribution of sampling points and to simplify fieldwork. A total of 492 stands were sampled.

Species Lists

Checklists were completed for amphibians, reptiles, birds, mammals, ferns and fern allies, and woody plants. In addition to ecological sampling of herbaceous communities, the vascular plants in prairies, glades, and wetlands were listed. Some high quality communities that could not be sampled with standard techniques (such as cliffs) were described with detailed plant species lists. A total of 2,511 species lists were completed. The relative abundance of each species was recorded as described in Appendix 29.

Section 13.
INFORMATION COLLECTED ABOUT THE NATURAL AREAS

Main Data Form

The following numbered items appear on the Main Data Form, which was completed for each natural area. A Main Data Form and instructions for completing the form are in Appendix 17. A description and the source of each item are given below unless the meaning and source of the data can be understood from the instructions in Appendix 17.

Not every item was collected for every area. For example, aerial photos with detailed overlays were completed only for areas with Category I significant features and for Illinois Nature Preserves. The boundaries and features of other kinds of natural areas usually were shown only with topographic maps and sketch maps.

Data for all items except those designated by a prime mark (') were computerized. Items designated with two asterisks are numerical values that can be analyzed with the computer's statistical programs. Items marked with one asterisk are encoded for computer searches and retrievals, but univariant statistics do not apply directly to these items. The remaining items are computerized as text, and they can be displayed but not analyzed by the computer.

(1) *Index number* (*).--An index number was assigned to each natural area by the computer. The number is used in computer operations.

(2) *County* (*)

(3) *Reference number*.--This number, in combination with the name of the county, is a unique identifier for the area. Reference numbers were assigned by the fieldworkers to identify areas in each county. Because all potential natural areas were assigned reference numbers, there are usually gaps between reference numbers for natural areas in the same county. For example, the two natural areas in Piatt County are Piatt 6 and Piatt 9 because numbers 7 and 8 were assigned to potential natural areas that were rejected.

(4) *Natural area name*

(5) *Natural area categories and significant features* (*).--See Section 4.

(6) *Exceptional features and notable features* (*).--See Section 5.

(7) *Preservation value score* (**).--This gives the evaluator's overall judgment of the value of preserving an area. The Department of Conservation requested that no guidelines be developed for determining the preservation value score, but that the evaluator record an estimate of the site's value relative to other natural areas. The preservation value score ranges from a low of 1 to a high of 5. (See Appendix 27.)

(8) *Evaluator*

(8') *Date of investigation*

(9) *Legal location.*--Location was recorded by section, Township, Range, and Principal Meridian. Each quarter-quarter section that included part of the site was recorded. The information was encoded for computerization, and the computer displays the information to the nearest quarter section. Also, the quarter-quarter section that includes the center of the area was encoded and computerized for a possible future computer mapping program.

(9') *Access*

(10) *Topographic quadrangle* (*)

(11) *Stream system* (*).--This item was termed *watershed* on the Main Data Form. Each natural area was classified according to the stream systems recognized by Smith (1971). The source for determining the stream system was a 1:500,000 scale base map of Illinois. (See Appendix 10.)

(12) *Specific stream.*--Source: Topographic map.

(13) *Legislative district* (*).--Source: Legislative district map.

(14) *Municipality.*--Source: County highway map or topographic map.

(15) *Altitude* (**).--Source: Topographic map.

(16) *Topography* (*).--The physiographic unit, major topographic feature, and individual topographic feature were recorded according to the classifications in Appendices 4, 5, and 6.

(17) *Geologic formation* (*).--Dr. H. B. Willman of the Illinois State Geological Survey determined the geologic formation for most natural areas from geologic maps, Geological Survey files, personal knowledge, and information recorded by the fieldworkers. Bedrock formations were recorded only if they were exposed. (See Appendix 7.)

(18-19) *Soil association* (*).--To determine the soil associations in each natural area, the staff used the *Soils of Illinois* book and statewide map by Fehrenbacher, et al. (1967) and county soil association maps available either in county soil reports or as separate maps. Both the county reports and the statewide reports were used because each had its own advantages that partly offset the disadvantages of the other. The statewide treatment in *Soils of Illinois* (Appendix 8) provides the only complete map and uniform classification of soil associations in Illinois, but the classification is generalized (26 associations) and the map is small. The county soil association maps are more detailed (often 10 to 20 associations in one county), but the equivalent association is often given different names on either side of a county line. As a result, the county soil association maps were considered to be relatively detailed and descriptive, but not part of a uniform classification system. The more general state soil association map was used to provide a uniform system for classifying soils in natural areas statewide.

(20) *Natural community classification* (*).--The term *community-type* on the Main Data Form was changed to *community class* in the final natural community classification system. (See Section 6 and Appendix 30.)

(21) *Rarity index* (**).--This is an estimate by the fieldworker of the abundance of each natural community relative to its presettlement extent. The index ranges from 1 for *abundant* to 5 for *very rare.*

(22) *Diversity index* (**).--This is a count of the number of natural communities in the natural area that have a natural quality of Grade A, B, or C.

(23) *Natural quality*

(a) *Acreage of natural communities by grades* (**).--If the natural area was mapped with overlays and an aerial photo, then the acreage of each community in each grade was measured with an area measurement grid. If the acreages were not measured, then a "P" for "present" was entered, and the computer displays the word "unknown" instead of an acreage figure.

(b) *Description of natural quality.*--Source: Field observations, aerial photo interpretation, and other sources such as discussions with landowners.

(24) *Total acreage* (**).--Sources: Measured with a grid from an aerial photo or topographic map, or occasionally taken from a plat book.

(25) *Vegetation types*

(a) *SAF cover type* (*).--When applicable, each plant community was classified according to the Society of American Foresters' (SAF) forest cover type (Society of American Foresters, 1967). The cover type was determined by field observations or vegetation sampling, but the classification was difficult to apply to this inventory for four reasons: (1) The definitions of some cover types are not broad enough to accommodate some communities. (2) The cover types are sometimes biased toward trees of economic importance. (3) Secondary successional communities are sometimes in the same cover type with stable, undisturbed communities. (For example, the *red cedar--hardwood* cover type is applicable to both abandoned farmland and sandstone glades.) (4) The "predominant" species in a cover type are supposed to be determined by density, but density was found to be so misleading that dominance was substituted. A

key to SAF cover types in Illinois was prepared to aid the fieldworkers. The SAF cover type classification is being revised, but the Inventory used the current classification because it is widely used in other natural area information systems. (See Appendix 9.)

(b) *Plant community* (*).--Sources: Field observation, vegetation sampling, aerial photo interpretation, and published studies.

(26) *Ownership type* (*).--Sources: Plat books or information gained by fieldworkers.

(27) *Number of owners* (**).--Sources: Plat books or information gained by fieldworkers.

(27') *Owner or custodian*

(28) *Use of natural area.*--Sources: Field observation, maps, and aerial photos. (See Appendix 11.)

(29) *Use of surrounding land* (**).--Land use within 1 mile of the boundaries of each natural area was estimated according to three categories:

(a) Wildland (forest, natural aquatic areas, abandoned farmland)

(b) Farmland (cropland, pastureland, orchards, farmsteads)

(c) Developed land (towns, factories, quarries, reservoirs)

Maps and aerial photos were the sources of the estimates.

(30) *Nearest SMSA* (*).--Source: Standard Metropolitan Statistical Areas (SMSA's) were drawn on a 1:500,000 scale map of Illinois.

(31) *Distance to the nearest SMSA* (**).--Source: Same as item 30.

(32) *Number of nearby schools* (**).--Source: The location of every academic college or university was drawn on a 1:500,000 scale map of Illinois.

(33) *Nearest school* (*).--Source: Same as item 32.

(34) *Number of nearby DOC facilities* (**).--Source: The location of every Department of Conservation (DOC) land management facility was marked on a 1:500,000 scale map of Illinois.

(35) *Land management facility* (*).--This is any agency that is an actual or potential manager of the natural area (Appendix 13). Sources: (1) Illinois Department of Revenue tax maps showing the boundaries of park districts, river conservancy districts, soil and water conservation subdistricts, forest preserve districts, and conservation districts, (2) plat books, (3) other maps showing the holdings of major land management agencies such as the U. S. Forest Service, and (4) information obtained by fieldworkers.

(36) *Manageability* (**).--Source: Field observation.

(36') *Management problem description*.--Source: Field observation. The problem and the probable effort needed to correct or contain the problem were described. (See Appendix 12.)

(37) *Preservation status* (*).--Source: Discussion with owner or custodian, or other means.

(37') *Attitude of owner or custodian toward preservation*.--Source: Discussion with owner or custodian, or other means.

(38) *Threats* (*).--Source: Discussion with owner or custodian, or other means.

(39) *Discussion of preservation values*.--This is a brief, nontechnical description of the area's important natural values.

(39') *Additional notes*

(40) *Species lists* (*).--This is a record of the kinds of species lists that were compiled for the area. The actual species lists are not computerized.

(41) *Sampling forms* (*).--Same as item 40.

(41') *Other materials*.--Other materials such as significant feature forms were noted.

(42) *Publications* (*).--This item was labeled *literature citations* on the Main Data Form.

Four other items were collected for each natural area, but it was not necessary to record the information on the Main Data Form:

Governor's Region (*)

Regional planning commission (*)

Forest preserve district (*)

Conservation district (*)

Because the boundaries of these regions coincide with boundaries of counties or groups of counties, the computer was programmed to retrieve the item by comparing the natural area's county with the proper value or description for the above items. Zoning information was not computerized for the natural areas, but a partial set of county zoning maps was assembled for reference.

Natural Area Files and Maps

Each natural area has a file consisting of a computer printout, Main Data Form, and boundary maps. Other materials include species lists, vegetation sampling forms, aerial photos with overlays, unpublished reports, and photos.

The natural areas were plotted on highway maps of each county, at a scale of 1 inch equals 2 miles. This set of maps was developed because they show at a glance the location of natural areas in each county. All natural areas were also marked with colored pins on a large-scale map of Illinois.

PART IV
SURVEYS

The purposes, procedures, and results of the various surveys are described in the following pages. Each kind of significant feature, from Category I through Category VII, was inventoried as a separate survey, but the surveys of different categories often were conducted concurrently.

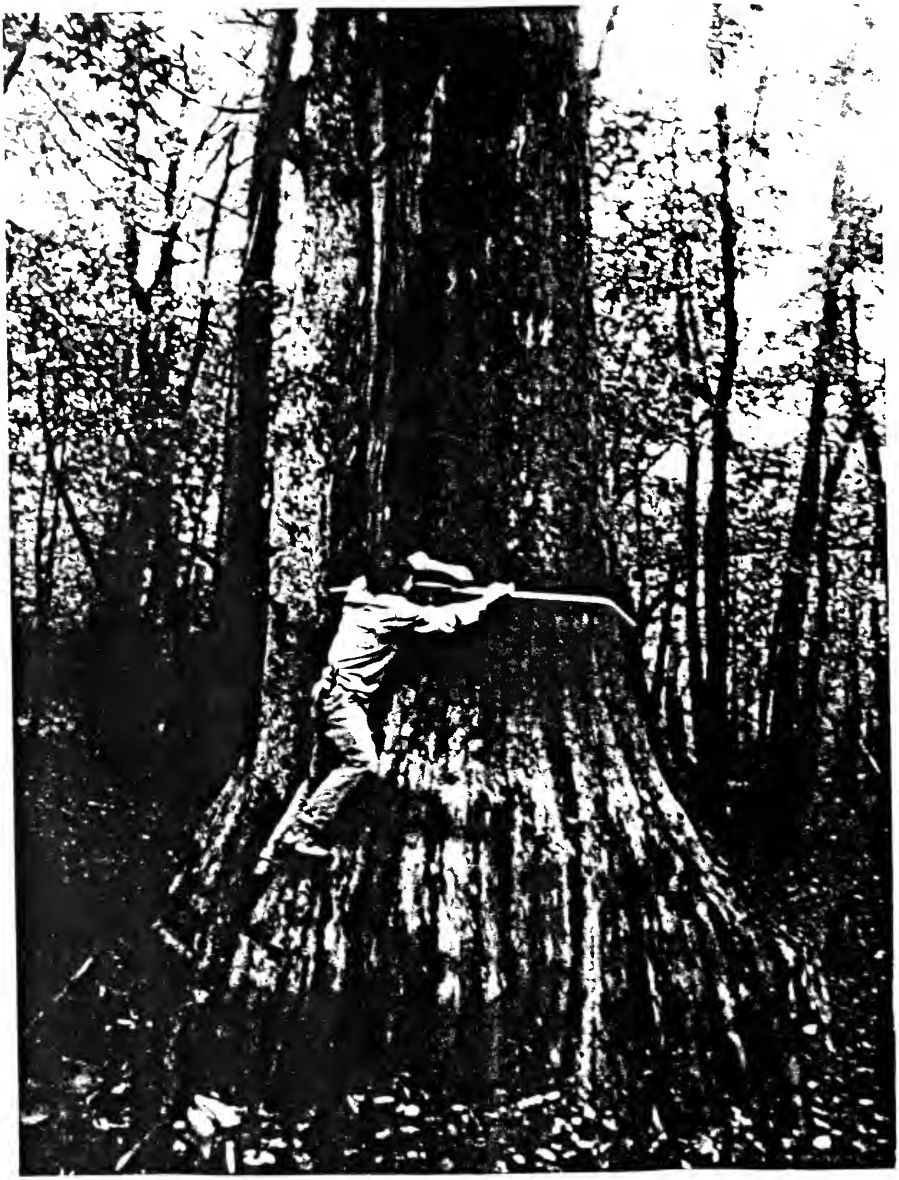

Plate 6. *A bald cypress along the Cache River. A few dozen of these ancient trees survive in the swamps of extreme southern Illinois.*

Section 14.

CATEGORY I SURVEY
MAIN SURVEY

Summary

The Main Survey was a search to find areas with relatively undisturbed natural communities, except for (1) prairies and savannas along railroads and in cemeteries, which were inventoried in separate Category I surveys, and (2) lakes and streams, which were included in the Category VII survey.

Although the Main Survey for Category I significant features was the largest effort of the Inventory, it is not detailed at this point because the standard techniques of compiling available information, examining maps and aerial photos, aerial surveys, and ground surveys are detailed in Part III and in appendices. The results of the entire Category I survey are summarized in Part V.

Special procedures were involved in surveying cemeteries and railroads, so these surveys were separate from the Main Survey and they are discussed in some detail in the following two sections.

Section 15.

CATEGORY I SURVEY
RAILROAD PRAIRIES

Summary

A systematic survey was conducted to find prairie remnants along railroads. An aerial survey, followed by brief checks on the ground, was conducted in the fall and early winter of 1975. The most significant prairie remnants were revisited to complete the final evaluations and descriptions in the summer of 1976. Sixty areas with a total of 123 acres of high to very high quality prairie communities were included in the inventory.

Introduction

Prairie remnants occur on railroad rights-of-way because many railroads were built before the prairies were cultivated. Prairies have persisted along railroads in the occasional places where they have escaped heavy disturbance during construction and maintenance of the tracks. Factors that have favored the persistence of prairie vegetation include (1) burning and mowing of the right-of-way to reduce woody invasion, (2) a great distance from any source of seeds from trees and shrubs, and (3) dry embankments and wet depressions, which favor native vegetation over exotics. Although prairie plants grow along nearly every mile of railroad that crosses a prairie region, prairie of the highest natural quality is on land that has been least disturbed by construction and maintenance of the railroad.

A large amount of literature demonstrates the importance of these remnants along railroads for scientific research and nature preserves. The value of remnant prairies along railroads was recognized by early plant ecologists such as Shimek (1925) in Iowa and Pepoon (1915, 1916, 1927*b*, 1928) and Vestal (1918) in Illinois. Botanists in Wisconsin have relied on railroad prairies for many studies; examples are by Gould (1941), Thomson (1940), Curtis and Greene (1949), and Wilson (1978).

Zoologists in Illinois also have frequently used railroad rights-of-way; examples of invertebrate studies are by Adams (1915) and Rapp (1946). Examples of vertebrate studies are by Hankinson (1915, 1917), Shackleford (1929), Koestner (1941), Goodnight and Koestner (1942), Long (1968), and Stupka, et al. (1972). Soil scientists use railroad prairies to study undisturbed soil profiles (see Douglas, et al., 1967). Prairie remnants are valuable natural preserves in other states as well, as is shown by articles and abstracts by Betz (1978) for Indiana; by Scharrer (1972), Thompson (1972), Kohring (1978), and Chapman and Pleznac (1978) for Michigan; and by Ramey (1978), Troutman (1978), and King (1978) for Ohio. Because of their value in Illinois, Vestal (1931) and Miller (1943) urged preservation of railroad prairies; Evers (1963), and Evers and Page (1977) described the natural values of railroad prairie remnants.

Procedure

The survey had four stages: (1) preparation for the field survey, (2) an aerial survey to find potential prairies, (3) an initial ground survey to determine the significant sites, and (4) a final field survey to describe and evaluate the significant prairies in detail. The first three stages were completed in the fall and early winter of 1975, and the final survey was conducted in the summer of 1976.

Preparation for the field survey

Preparation consisted of (1) learning and refining survey procedures, (2) compiling available information about railroad prairies, and (3) examining maps and aerial photos to determine which railroads have potential for prairie remnants.

Pilot study and training session.--As part of the contract proposal, a 70-page plan for surveying railroad prairies was written. Later, during the earliest stages of the project, more railroad prairies were visited and people were contacted to (1) refine the estimates of the size of the survey, (2) learn more about evaluating prairies, and (3) further test and develop survey techniques. The staff ecologists participated in a 6-day training session that included instructions in an airplane and on

the ground, fieldwork as individuals and in teams, and discussions and reviews of techniques.

Compiling available information.--Reports from the Illinois Department of Conservation, Natural History Survey, and Nature Preserves Commission were the main sources of existing information. The information consisted of locations and brief descriptions of stands of prairie vegetation along railroads, and it was used to choose sites for testing the survey procedures.

Examining maps and aerial photos.--Various maps and aerial photos were used to decide which railroads should be surveyed. A discussion of the factors that affect the potential for significant railroad prairies is in Appendix 23. Briefly, the stages were as follows:

(1) A series of railroad maps was examined to find lines that were built so recently that the prairie would have been destroyed before the tracks were laid. Railroads built after 1891 were not selected for surveying unless they were on sandy or wet soil. Relatively few railroads were eliminated in this manner because the great majority were built by 1891.

(2) Railroads were eliminated if they followed forested floodplains or crossed wooded hills. A presettlement vegetation atlas (Appendix 19) was used in this stage.

(3) Examination of topographic maps and aerial photos revealed that some rights-of-way were so narrow that they could accommodate only the railroad roadbed, embankments, and ditches. These lines, which have hardly any undisturbed soil, were not surveyed.

The product of this stage was a set of county maps and a state map with the railroads color-coded to show their potential for prairie remnants. Of the 11,000 miles of railroad track outside of urban areas, 7,000 miles needed to be flown.

Aerial survey

The aerial survey was conducted in the fall, when the prairie grasses are brightly colored and highly visible from the air. Surveying

from an airplane during the growing season is not effective because prairie cannot be distinguished from weeds and naturalized grasses when the vegetation is green.

Before each flight, a flight plan was drawn on a 1:500,000 scale map of Illinois and on larger-scale (2 miles per inch) county highway maps. The rights-of-way were viewed from a Cessna 172 at 500 to 800 feet above the ground, and a few hundred feet horizontally from the tracks, at anywhere from 70 to 120 miles per hour depending on the amount of prairie. Potential prairies were marked on county highway maps, and observations were recorded on tape during the flight. Since most tracks are paralleled by utility poles, a typical observation would be, "Dense stand of big bluestem on south side of tracks in section 23, beginning four poles east of blacktop and extending 13 poles farther east." For some lengths of right-of-way, the only observation might be, "Right-of-way consists of brushy and weedy embankments with occasional clumps of prairie grass." After the flight, the tape-recorded observations were transcribed onto the aerial survey section of a preliminary data form.

Selection standards were kept relatively low to avoid overlooking significant sites. At first the fieldworkers were overly cautious and selected sites that later would have appeared obviously too small or degraded. A total of 667 potential prairies were selected during the aerial survey.

Initial ground survey

The sites selected during the aerial survey were given an initial ground survey during the fall and winter to briefly determine the natural quality and characteristics of each area and to select the least disturbed remnants for detailed description and evaluation during the next summer. Degree of disturbance was the basis for evaluating the prairies. The most prominent indicators of disturbance of a railroad prairie are the soil and the vegetation.

Soil.--Disturbance to the soil is the major reason prairies have been destroyed or degraded. The soil on rights-of-way has generally

been disturbed by (1) construction of cuts and fills to make an even grade for the roadbed, (2) ditching, (3) grading to remove brush and smooth the surface contours, (4) bulldozing to repair the roadbed, (5) excavations to obtain fill for the trackway or road crossings, (6) spreading of cinders and ballast, (7) service roads, (8) cultivation, (9) local disturbances such as derailments, and (10) changes in drainage patterns. Soil disturbances were detected and evaluated by (1) looking for unnatural surface contours such as ridges and depressions paralleling the tracks and abrupt changes in the surface contours, (2) studying soil profiles, and (3) examining the species composition of the vegetation.

Vegetation.--This is one of the most complex and variable features of a prairie. The following features were noted when evaluating the species composition: (1) presence of characteristic prairie species, (2) presence of rare species with narrow ecological tolerances, which cannot tolerate disturbance, (3) presence and relative abundance of species that increase with disturbance, and (4) diversity of species.

Natural quality.--This measure of the degree of disturbance is discussed in more detail in Appendix 22. In relation to railroad prairies, the grading system was used with the following guidelines:

Grade A: Natural prairie.--Species composition is natural or nearly so, with a full diversity of forbs and without an overabundance of weedy species. Soil is undisturbed by earthmoving; or it may have been lightly disturbed but the vegetation appears natural.

Grade B: Disturbed prairie.--Species composition is altered from the original natural condition. Some characteristic prairie plants are absent; others are overly abundant. There may be patches of native weeds and many exotic species. Soil is typically lightly graded or otherwise disturbed.

Grade C: Degraded prairie.--Species composition is unnatural. There may be only scattered clumps and irregular, discontinuous patches of grass, with a dominance of weedy vegetation.

Grade D.--Occasional prairie plants grow on soil that is either disturbed or undisturbed.

Grade E.--Prairie plants are essentially absent because of disturbance.

Preliminary data collection.--Each of the sites visited was briefly described on a preliminary data form. The significant sites were described in more detail with an initial ground survey form, species checklists, and a sketch map. The initial ground survey form provided a means for recording (1) basic information such as the location of the prairie, (2) descriptions of the natural features, and (3) evaluations of the natural quality and preservation values of the prairie. Checklists allowed notation of the presence and relative abundance of prairie plants, and sketch maps showed the general location, size, boundaries, and characteristics of the sites. The procedures for the initial ground survey are described in a report listed in Appendix 33.

Final field survey

Forty of the 104 prairies that passed the initial ground survey were found to not qualify as natural areas during the final field survey because they had low diversity. This relatively high percentage of areas was eliminated because the staff was conservative while learning during the previous fall and winter, thinking that too many prairie species might be overlooked in the dormant season. In the following summer the staff learned that it would have been possible to adequately judge a prairie's relative diversity in the winter, because the prairie remnants that appeared to have low diversity in the winter actually did prove to lack many species when revisited in the summer.

Results

Of the 64 prairies that were not eliminated during the final field survey because of past disturbances, 60 were designated as natural areas; four had been plowed or bulldozed since they were visited the previous autumn.

Natural areas

The 60 railroad prairies have 40.25 acres of Grade A and 82.45 acres of Grade B land in 11 natural communities: dry prairie, dry-mesic prairie, mesic prairie, wet-mesic prairie, wet prairie, dry sand prairie, dry-mesic sand prairie, mesic sand prairie, wet-mesic sand prairie, wet sand prairie, and dry gravel prairie. The railroad prairies are in 29 counties, along tracks owned by nine different companies. The railroad prairies are the only natural black-soil prairie remnants in 12 counties.

Disturbances

Since such small remnants were found along the railroads, a discussion of the disturbances that have nearly eliminated the natural areas is pertinent. The major disturbances to railroad prairies have been grading of the soil during construction and maintenance of the tracks, cultivation, and herbicide spraying. Rights-of-way are usually only wide enough to accommodate the roadbed, embankments, and ditches; if the right-of-way is wider, then the extra land has usually been graded, which removes the topsoil and encourages weeds. If ungraded land has been left so that it could have supported prairie, it is almost invariably cultivated. Prairie plants often grow on the most disturbed soil, where the land is too roughly graded to cultivate, or on excavations, dry cuts, and unnaturally wet areas where the native species can compete successfully with exotic plants. The third major disturbance, herbicide spraying, has recently damaged many prairies by either killing the native cover so that it is replaced by weeds or by eliminating the forbs and leaving only grasses.

Section 16.

CATEGORY I SURVEY
CEMETERY PRAIRIES AND SAVANNAS

Summary

This section discusses the procedures and results of a survey to find remnants of prairie and savanna vegetation in Illinois cemeteries. The survey, conducted from August to October 1976, relied heavily on volunteer help and previous surveys. Information was compiled for 3,923 cemeteries. Twenty-four sites were listed as natural areas because of their relatively undisturbed vegetation and soil, and 111 other cemeteries have native vegetation with potential for recovery.

Introduction

Settlers of the Illinois prairie established cemeteries on land that had never been plowed or intensively grazed. Some of these early graveyards support native prairie and savanna vegetation in parts that have not been mowed frequently. Other cemeteries have savanna vegetation because they are mowed or burned often enough to suppress woody plant succession, but they have not been so closely manicured that the native forbs have been replaced by other species.

Dr. Robert F. Betz has pioneered in finding, preserving, and studying prairie remnants in cemeteries. He advised the project and contributed knowledge gained from visiting over 800 cemeteries in northern Illinois.

A few papers have been prepared about cemetery prairies in Illinois to stimulate interest in preservation of the remnants. These include articles and abstracts by Betz (1972, 1976), Betz and Lamp (1973), the Illinois Nature Preserves Commission (1977), and Keller (1978).

Procedure

Procedures were developed for the cemetery survey in a 31-page plan that was part of the contract proposal. Instructions to the fieldworkers are in two reports listed in Appendix 33. The basic stages of the survey are discussed below.

Office preparation

Preparation consisted of (1) finding cemeteries on maps and from other sources such as genealogists, and (2) deciding which ones should be checked in the field. All topographic maps and county highway maps for the state were reviewed, except for nine counties that had no prairie at the time of settlement. Both kinds of maps were checked because each kind had cemeteries that the other omitted. The *Presettlement Vegetation Atlas* (Appendix 19) and soil maps were used to decide which cemeteries had potential for prairie or savanna remnants. The result was a set of county highway maps with cemeteries color-coded to indicate which were to be field checked.

The staff attempted to reduce the number of cemeteries to be surveyed by learning which ones were established after 1900, when almost all upland prairie would have been farmed. Use of the following sources was explored: old atlases, State agencies, genealogical societies, historical societies, libraries, church organizations, morticians' organizations, and cemetery associations. These approaches were not productive because most cemeteries were established well before 1900, and the sources did not have exactly the information needed (Appendix 24).

Pilot survey

A staff member and a volunteer surveyed 73 cemeteries in four counties to test and develop the survey methods. Suggestions to volunteers on equipment and procedures were based on this survey.

Volunteer survey

Individuals volunteered to do a county or counties, and the basic requirement was that one volunteer per team be able to identify prairie plants. The volunteers were given county highway maps with cemeteries

marked to show which ones needed to be checked, and they were given forms and instructions. The fieldworker did the following: (1) recorded basic information such as the date and name of the investigator, (2) visited each cemetery and assigned it a number on the map and form, (3) noted whether the cemetery was on prairie, forest, or transitional soil, (4) made a list of prairie plants in the cemetery, (5) gave an opinion about whether the cemetery was a *nonqualifying area*, *notable area*, *marginal area*, or *natural area*, and (6) recorded any other pertinent observations.

Staff survey

The species lists that were completed by volunteers were studied by the staff, and a ranking system for prairie plants was used to help decide which cemeteries should be revisited. The prairie plants were placed in five groups:

I. Weedy native plants, often present in prairies because of disturbance, and common or abundant in non-prairie habitats. Examples: Whorled milkweed, frost aster, tall boneset, and tall goldenrod.

II. Typical prairie plants that can withstand heavy disturbance or readily invade disturbed sites. Examples: Big bluestem, Canadian tick-trefoil, big-toothed sunflower, and pasture rose.

III. Typical prairie plants, often eliminated by heavy disturbance, but not by light to moderate disturbance. Examples: Pale coneflower, downy sunflower, rosinweed, and Culver's root.

IV. Prairie species similar to Group III, but less likely to invade disturbed areas. Examples: White wild indigo, prairie willow, and compass plant.

V. Conservative prairie species, usually indicating lack of disturbance. Examples: Lead plant, cream wild indigo, wood lily, and white prairie clover.

The cemeteries were scored with a point system according to the number and kind of species present. Group I and II plants scored one point, Group III plants were given three points, and Group IV and V plants received five points. As a general guideline, cemeteries with

about 40 or more points were rechecked by the staff, although the volunteer's description of the cemetery's potential as a prairie preserve and the degree of confidence in the volunteer's work were also considered.

The staff noted whether the cemetery was: (1) a *natural area*; (2) a *notable area* with (a) *high*, (b) *medium*, or (c) *low* potential for recovery with management; or (3) a *nonqualifying area*. A brief form was completed for each cemetery visited, and the natural savanna or prairie remnants were surveyed with the standard Inventory forms and procedures.

Results

Natural areas

Twenty-four cemeteries were judged to have significant natural areas. These areas total 14.8 acres of Grade A and 26.6 acres of Grade B communities. Eight communities are represented: mesic prairie, dry-mesic prairie, dry-mesic sand prairie, loess hill prairie, glacial drift hill prairie, dry-mesic savanna, and dry sand savanna. The cemeteries contain the only black-soil prairie remnants in seven counties and the only dry-mesic savanna natural areas in Illinois.

Notable areas

One hundred and eleven notable areas of disturbed prairie or savanna, valuable for teaching or research, were identified. Thirty-five of these areas have high potential for recovery to high natural quality, probably with 5 years or less of management. Although it often is necessary to study the vegetation with several visits throughout the growing season to determine a remnant's potential for recovery, 33 cemeteries were tentatively classified as having medium potential and 43 cemeteries as having low potential for recovery with management. Work by Dr. Betz and others has shown that some mowed cemeteries do not show their true potential for recovery until they have been protected and managed for a few years.

Section 17.

CATEGORY II SURVEY
HABITATS WITH
RARE, THREATENED, AND ENDANGERED SPECIES

Definitions and Procedures

Introduction

The Category II survey included vertebrate animals and vascular plants that are rare, threatened, or endangered in Illinois. The term *endangered* is used in the following discussion as a general adjective, equivalent to *rare*, *threatened*, or *endangered*, unless the context of the discussion dictates otherwise.

People and organizations involved with endangered species

Many people and groups have studied, protected, and compiled lists of endangered species and their habitats in Illinois. The Illinois Endangered Species Protection Board is the official State agency concerned with endangered species. The Illinois Department of Conservation administers the Endangered Species Protection Act, protects certain endangered animals through fish and game laws, and manages some areas to maintain endangered species. The Illinois Nature Preserves Commission is involved with the acquisition and protection of habitats with endangered species and has been involved with determining the status of endangered animals and plants. The Illinois Natural History Survey has contributed much work and knowledge toward development of endangered species lists and conducts research and management work on endangered species. The Illinois State Museum has compiled information about endangered species and has contributed this knowledge to help determine the population status of Illinois' native flora and fauna. The Illinois Department of Transportation has published a summary of endangered species records, and the U. S. Forest Service has funded studies in the Shawnee National Forest. Many people have conducted research and contributed knowledge as individuals or as members of various museums, environmental organizations, and academic institutions.

The Natural Land Institute received a grant in 1977 from the Joyce Foundation to conduct a year-long Endangered Species Project. The purpose of the project was to compile information on the distribution, population status, and habitats of vertebrate animals and vascular plants that are rare, threatened, or endangered in Illinois. With contributions from specialists, the Endangered Species Project is preparing a publication that will cover the above points and make recommendations for protection and management of species.

The Natural Areas Inventory and the Endangered Species Project shared the tasks of compiling information from museum and herbarium searches, reviewing research files and literature, field surveying, and interviewing biologists. The Inventory concentrated its efforts on identifying and describing specific sites for endangered species, and the Endangered Species Project was oriented toward determining the population status and management needs of endangered species. Consequently, the Endangered Species Project took the major responsibility for compiling distribution records and making a preliminary determination of each species' population status, and the Inventory concentrated on fieldwork.

Determining the status of species

The Inventory and the Endangered Species Project had the benefit of various endangered species publications and preliminary lists contributed by many cooperating individuals and agencies. The Inventory hosted a series of workshops conducted by the Endangered Species Project, at which specialists discussed fishes, amphibians and reptiles, birds, mammals, and vascular plants. Interim lists prepared by the Nature Preserves Commission and Department of Conservation served as the bases for discussions. For animals, the workshop participants designated each species as either: (1) recommended for state endangered status, (2) recommended for state threatened status, (3) assigned to rare, restricted, uncertain, or exploited status, or (4) deleted from the list because the species is either too common, probably extirpated, or of questionable occurrence in Illinois. Because of the large number of plants considered (about 500) the designations by the botany workshop were more general, and more effort was spent simply adding or deleting species. The status of each

species was determined by using the criteria outlined in Appendix 25 as guidelines, but in practice the workshop participants usually reached a consensus without lengthy analysis. This screening process was a practical and expedient way to prepare for further work.

As a result of the workshops, the Natural Land Institute's Endangered Species Project submitted to the Endangered Species Protection Board a list of plants and animals recommended for official designation as endangered and threatened species in Illinois. The Board invited comments from the public on its own preliminary list, and in December 1977, the Department of Conservation issued an administrative order listing the vertebrate species adopted by the Endangered Species Protection Board as endangered and threatened in Illinois. The Board adopted the following definitions:

Federally endangered species.--Any species which is in danger of extinction throughout all or a significant portion of its range.

Federally threatened species.--Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

State endangered species.--Any species which is in danger of extinction as a breeding species in Illinois.

State threatened species.--Any breeding species which is likely to become a state endangered species within the foreseeable future in Illinois.

Significant features and exceptional features

When the Inventory began its survey for endangered species, a final list of endangered species based on sound information was not available. The Inventory did not attempt to make a final determination of each species' status, but used the concept of *significant features* and *exceptional features* instead of the terms *endangered* and *threatened*. Significant feature status was limited to species so rare in Illinois that they merit special preservation efforts. If a species was given significant feature status, then every known occurrence of the species in Illinois was a Category II natural area.

A plant species was considered a significant feature if currently known from three or fewer sites in Illinois. A plant would qualify as a significant feature if known from five or fewer stations on a vulnerable site such as a wetland, prairie, or mineable mineral. Exceptional feature status was given to any plant species that was too common to qualify as a significant feature, but was rare enough to add exceptional value to an area. Because the Inventory lacked comprehensive knowledge about the relative abundance of these less-threatened species, an upper limit was not set for the number of sites from which a plant could be known and still be considered an exceptional feature. However, a plant usually was not listed as an exceptional feature if known from more than 15 sites.

Animals were treated in a manner similar to plants, but species were not as readily assigned significant feature status. Most animals are mobile or secretive, so their numbers and distribution are not determined as readily as for plants. For example, several birds are listed as endangered by the Endangered Species Protection Board but few natural areas were included as habitat for endangered birds, for two reasons: (1) Particularly for birds of prey, rarely could sites be identified where the species nests reliably from year to year. (2) In the case of marsh birds and waterfowl, the staff sometimes had reports of 10 to 15 possible nesting sites, but none was listed as a significant feature because the best breeding sites could not be determined. Most likely many of these secretive wetland inhabitants are more common than is readily apparent, and the Inventory could not confidently choose the sites most critical for the species' survival in Illinois.

Although large areas were recognized for the river otter and greater prairie chicken, another problem is illustrated by the bobcat, which ranges so widely that it was not possible to identify specific areas as critical habitat. Fishes known only from Lake Michigan or from a few collections in the Mississippi or Illinois rivers were not listed in the inventory.

During the endangered species workshops, the terms *rare*, *restricted*, or *uncertain status* were assigned to some species that appeared on earlier preliminary lists. The term *rare* was used in reference to species

that have low population levels but are not threatened or endangered with extirpation. *Restricted* status was assigned to species with very limited ranges in Illinois. *Uncertain* status was given to species for which insufficient information was available regarding population status. These terms are not used or defined in Illinois or Federal endangered species laws. Species in these categories were usually treated as exceptional features.

Inventory procedures for animals

The project relied largely on information from other people and agencies to identify habitats with endangered vertebrates. Gathering this information was a joint effort between the Inventory and the Endangered Species Project. The main sources of locality records are described in the following paragraphs.

Fishes.--The project relied on the computerized records of the Illinois Natural History Survey, which has data from its own long-standing collections as well as records of collections made by other investigators.

Amphibians and reptiles.--The Natural History Survey compiled records of endangered amphibians and reptiles for the Endangered Species Project. The work involved gathering collection data from scientific organizations and herpetologists throughout the state.

Birds.--A wealth of information was available from amateur birders, the Department of Conservation, Natural History Survey, other professional ornithologists, and the literature.

Mammals.--Information from published sources and museum collections was used, but most knowledge of the current populations of endangered mammals came from fur trappers, wildlife biologists, and mammalogists at universities. The project sought information about bobcats, swamp rabbits, and other conspicuous mammals by distributing questionnaires to hunters at deer check stations, but the information gained in this manner was of little value.

Field searches.--Although special surveys to find new populations of endangered vertebrates were not a part of the inventory project, the staff did some fieldwork to verify reports of endangered animals and

searched for these species during other field surveys. The project provided travel expenses for volunteers who checked specific sites and searched for certain species. Returns from these efforts were minimal, because surveys for vertebrates require more time and persistent effort than was exerted.

Inventory procedures for plants

The main sources of plant locations were herbaria, literature, personal knowledge of botanists, and files of various agencies. The Endangered Species Project took responsibility for organizing this information, and the Inventory helped gather the records. The Endangered Species Project compiled lists of sites for each county, giving the pertinent collection data for each species. The Inventory staff chose sites from these lists with recent and precise enough locality data that there was some promise that the plant could be relocated. The collector was contacted when possible and necessary in an attempt to get current information and directions to the site. The effort expended in the field depended on how promising a site appeared once it was visited: some sites had been destroyed and other sites offered no clues about specific areas in which to concentrate the search. Between five and 20 sites were visited in a typical day.

Some sites were not visited, if enough current information was available about the species' population, location, and habitat. About 18% of the Category II plant significant features were found because of fieldwork unsupported by past collection records or observations. These were either species found by specially searching suitable habitats or species found during the Category I and III surveys. Appendix 26 details some of the survey procedures and relates some experiences that might help other endangered plant surveys.

Results

The animals and plants are listed in Appendix 3, with the following information for each species: (1) status according to the Endangered Species Protection Board (for animals), (2) status recommended by the Natural Land Institute's Endangered Species Project (for plants), (3)

number of sites identified as significant features, and (4) number of sites identified as exceptional features.

Number of significant features and exceptional features

The number of significant feature (SF) and exceptional feature (EF) occurrences in natural areas are as follows:

	SF's	*EF's*
Fishes	7	44
Amphibians and reptiles	18	67
Birds	23	145
Mammals	11	25
Vascular plants	462	629

Habitats and distribution

Endangered animals and plants occur in a wide variety of habitats throughout the state, but the greatest numbers are in wetlands in extreme northeastern and southern Illinois (Figure 2). Wetland and prairie species are most often endangered because the habitat is endangered.

Endangered plants were most often found in high to very high quality natural communities, as shown by the number of significant features in each natural quality grade:

Grade A:	146
Grade B:	114
Grade C:	161
Grade D:	25
Grade E:	16

Twenty-five of the Grade A habitats are cliffs and bluffs, but most are prairies and wetlands. Many endangered plants require early successional communities, but they are usually in naturally disturbed areas or primary successional communities rather than artificially disturbed sites. A few endangered plants were found in artificial sites, especially ponds and ditches.

Endangered animals appear to be more tolerant of disturbances, as shown by this tabulation of significant and exceptional feature occurrences:

Grade A:	3
Grade B:	6
Grade C:	34
Grade D:	11
Grade E:	5

Part of the reason that more animals are in disturbed communities is that many species are mobile and require rather large territories, and the only sizeable habitat remaining for them has been disturbed by humans. The most extreme example of an artificial habitat is an abandoned underground limestone mine that has the only known hibernating colony of the endangered Indiana bat in Illinois.

Newly discovered species

Three aquatic plants were discovered for the first time in Illinois. Other plants that had not been seen in Illinois in many decades were relocated, and some species thought to be endangered were found in so many localities that they were deleted from the tentative endangered species list.

Prior to the inventory, the red squirrel was thought to have been extirpated from Illinois by the early 1900's. The red squirrel is a small animal of northern forests, unlike its larger, reddish relative, the fox squirrel, which is common throughout the state. Although the red squirrel had not been listed as part of the current Illinois fauna, the staff found red squirrels in four northern Illinois counties in 1977.

Section 18.

CATEGORY III SURVEY
HABITATS WITH RELICT SPECIES

Definition

Category III significant features are habitats with relict species. A relict species is one that occurs in a small, disjunct population that is a survivor of a formerly more widespread population. The range of the relict species has disintegrated or retreated because of climatic changes, and the species remains in a local, specialized habitat that provides a suitable microclimate and allows it to survive competition from other species.

An operating definition of a relict habitat--exactly what to include in the inventory--required much study and discussion by the Inventory staff. Theories of the geographic origins and climatic changes that have affected the modern flora were debated. There were sometimes questions about whether a colony was an outlier of an expanding population or a relict of a contracting population. Some small, scattered populations might be relicts or they might be the result of a lack of suitable habitat at the edge of a species' range.

The following guidelines were established: (1) A plant should be disjunct by at least 100 miles from its normal range. (2) Assemblages of more than one relict species, rather than sites with single species, were considered. (3) An open-ended list of possible relict or disjunct species was made, and two or more of these species had to be present on the same site because of approximately the same unusual habitat requirements in order for the site to be a relict habitat. Although animals, especially invertebrates, are sometimes part of relict associations, analysis was limited to plants.

Procedure

The Category III survey used the same techniques of compiling background information, contacting people, examining maps and aerial photos,

aerial surveys, and ground surveys as for the Category I survey. These survey stages were usually conducted at the same time as the search for Category I and II significant features. The survey was a search for habitats rather than individual species, so sites with unusual soil and topography that were known in general to have relict species were surveyed. These habitats include seeps, sand areas, moist cliffs, and ravines and bluffs along Lake Michigan. Some other communities, such as hill prairies, might be considered relict habitats, but they were simply considered as part of the Category I survey.

Not all of the thousands of cliffs and seeps in Illinois could be searched for relict plants, and such a detailed search was not necessary because only the largest seeps and shaded cliffs are likely to maintain an adequate habitat for relicts. For example, the smaller bedrock outcrops are more likely to have been periodically covered by soil; also, they have relatively little effect on the microclimate and provide little area for colonization. Similarly, small seeps are likely to go dry periodically or to lose species through local extinction. The approach was to check the largest first; if these largest sites had relicts, then smaller sites were visited. It was found that relict assemblages were nearly all restricted to the largest and most extreme sites.

Results

Thirty-nine sites with a total of 45 Category III significant features were listed. Twenty-five sites are cliff habitats, six are on bluffs or in associated ravines, five are seeps, and three are in sand prairie or barren communities.

In northern Illinois, the relict sites are on cliffs, in seeps, or along the Lake Michigan bluffs. The most common relicts are white pine, Canada yew, and sullivantia. There were a few relict sites in sand areas and seeps in central Illinois, but no relict species can be named as particularly frequent in these communities. In southern Illinois, the relict assemblages occur on moist, shaded sandstone cliffs and in seeps. Cinnamon fern, hay-scented fern, clubmosses, and sphagnum moss are the most frequent relicts, but about 12 other species are relict associates.

Section 19.

CATEGORY IV SURVEY
GEOLOGIC AREAS

Definition and Procedure

Category IV significant features are outstanding representatives of the state's geologic diversity. This category includes areas that are outstanding because of stratigraphy and sedimentation, igneous rocks, geologic structures, topographic features, and fossil localities. Geologic areas differ from other categories of natural areas in the following respects:

(1) Geologic features are in general not threatened because they are usually large, numerous, and not vulnerable to destruction.

(2) Many significant geologic features extend over large regions, and it is not always easy to designate a small site to represent a large-scale feature.

(3) Human disturbances such as roadcuts and mines are often important advantages to geologists, because the disturbances provide fresh rock exposures for study.

Because of the above factors, geologic areas were inventoried in a different manner. Unlike ecological areas, where the goal was to list every occurrence of a particular significant feature, only representative sites were chosen for geologic areas. Areas were selected to form a system that, taken as a whole, represents the geologic diversity of the state.

The inventory of geologic areas was compiled by Dr. H. B. Willman of the Illinois State Geological Survey. In addition to the information recorded for other kinds of natural areas, Dr. Willman described the nature of the exposure (streamcut, roadcut, etc.) and noted whether the site has a type stratigraphic section.

Selecting geologic areas.--Because there were often several outstanding examples of the same geologic feature, preference was given to areas with the following characteristics:

(1) Natural exposures
(2) Sites with a variety of geologic features
(3) Sites where preservation might be practical
(4) Sites with type geologic sections or published studies

Determining boundaries.--Boundaries were drawn to adequately represent the significant feature. For example, in some cases a small section of a cliff was chosen even though the same rocks are exposed for a mile or more along the valley wall. Some sites were mapped somewhat larger than needed to make an adequate example because the precise location of the most significant exposure could not be determined without a field examination.

Results

One hundred and sixty Category IV significant features were identified. The following kinds of geologic features were represented (with the number of significant features selected):

Stratigraphy and sedimentation.	106
Igneous rocks	2
Geologic structures	8
Topographic features.	24
Fossil localities	20

Of the 106 stratigraphic areas, 53 are natural exposures and 16 are partly natural. One hundred and twenty of the 143 geologic formations in Illinois are in geologic areas. None of the geologic areas are in active quarries, pits, or mines, except for an outstanding crinoid locality that is in the inactive part of an active quarry.

In listing geologic areas, many sites were considered and many difficult choices were made. As a supplement to the sites listed as Category IV significant features, an annotated list of 119 major alternative sites and 10 historically important geologic areas was compiled.

Section 20.

CATEGORY V SURVEY NATURAL STUDY AREAS

Definition

Natural study areas are sites managed and used as nature preserves or natural areas for teaching and research. A site qualified as a natural study area if managed and used for natural science studies, even though it might have been disturbed and lacked any other significant feature. This category of natural area includes two groups: (1) areas maintained and used by local groups and schools, and (2) areas protected as nature preserves.

School natural areas.--The following guidelines were used to recognize these areas:

(1) *Protection.*--If the area is owned by a school, then the school administration must have given the area some type of protected status. If the area is not owned by a school, then the school must have a lease or written agreement with the owner to maintain the tract as a natural area.

(2) *Permanence.*--The area must have at least a 3-year program of use. That is, the area must have been used for at least 3 years, or it must be committed to a 3-year program if it has recently been established.

(3) *Use.*--Research and education must be the main use of the area. Land that is primarily used for recreation or simply as a wildlife refuge does not qualify. Experimental areas (for example, mowed or plowed areas) do not qualify. A tract does not qualify if it has been set aside but is not studied.

(4) *Natural quality.*--The area must be relatively undisturbed, or it must have recovered from disturbance so that the vegetation is dominated by native species and is not in the earliest stages of secondary succession. In general, the area must have natural communities

> that are Grade C or higher. However, abandoned fields may qualify if natural succession is being studied. Prairie restorations may qualify as natural study areas.

Many areas used by schools did not fit well under these criteria, which is understandable because the schools did not establish areas under the Inventory's guidelines. The two most common problems were that the school set aside an area for nature study but never established exact boundaries, and that the area has other uses in addition to nature study. In such cases the boundaries were drawn for the inventory using the best available information to include only land that has nature study as its main use.

Nature preserves.--The second group of natural study areas are sites that are specially protected as nature preserves or are part of a formal system of natural areas. This group includes Illinois Nature Preserves (Illinois Nature Preserves Commission, 1977), Federal Research Natural Areas (Federal Committee on Ecological Reserves, 1977), Registered Natural Landmarks (Wieting, et al., 1977), Society of American Foresters' natural areas (Buckman and Quintus, 1972), and lands held by The Nature Conservancy, the Natural Land Institute, and similar land preservation organizations.

Procedure and Results

Elementary and secondary schools.--With help from the Illinois Office of Education, a questionnaire was sent to all 211 private secondary schools and to all 1,030 public elementary and secondary school districts (representing 4,536 schools), asking whether they used an area for nature study. The schools were asked to return the questionnaire even if they did not use such an area. Of the 1,241 schools or districts surveyed, 642 (or 52%) replied, and 135 (or 11%) reported that they owned or used natural study areas. If a school responded positively, a second questionnaire was sent, asking for more detailed information and asking for a map showing the boundaries of the area. Some of the positive responses were not included in the inventory, usually because the area did not meet the project's criteria or because the school

gave insufficient information about the area. As a supplement to the questionnaire survey, Donald Greene and Robert Walker generously shared the results of an unpublished 1976-77 survey of outdoor classrooms in Illinois by the Illinois Chapter of the Soil Conservation Society of America. The final number of sites listed because of the survey of elementary and secondary schools is 45 areas.

Colleges and universities.--The 113 academic colleges and universities that have biology or related curricula were surveyed in a manner similar to elementary and secondary schools, but the staff also relied on personal knowledge and contacts to supplement the mailed questionnaire. Forty areas were listed as Category V areas because they are used or managed by colleges or universities. Some of these sites had been listed in a previous survey by the Illinois Board of Higher Education (1975).

Nonacademic organizations.--Forest preserve districts and conservation districts were asked about land that the district specially maintained as nature preserves or education areas. Thirteen of the 17 districts responded, with descriptions of 31 areas. The largest park districts were contacted, but the Inventory relied on the questionnaires that were sent to schools to learn about most park district areas. Other organizations involved in natural area preservation were contacted, such as the Natural Land Institute, The Nature Conservancy, the Parklands Foundation, and the Forest Park Foundation. Information was solicited in several statewide news releases and various newsletters, including a mailing to all the soil and water conservation districts in the state.

As a result of the survey, 266 Category V significant features were listed in 251 areas, including 66 Illinois Nature Preserves, 16 Federal Research Natural Areas, and nine Registered Natural Landmarks.

Section 21.

CATEGORY VI SURVEY
UNIQUE NATURAL AREAS

Definition and Procedure

Some sites were recognized as natural areas because they have unique features: these are areas worthy of preservation efforts that do not fit well in the other natural area categories defined by the Department of Conservation.

For example, two tracts were recognized because of their ancient bald cypresses and tupelos. The trees themselves--with their great age and their own plant and animal communities--are sufficient reason to preserve the swamps. (In both tracts with these trees, the swamps did actually qualify as Category I significant features. Other significant features usually occur with Category VI features, and only five areas were simply Category VI.)

Several caves were included as Category VI sites because of their outstanding invertebrate fauna. Otherwise, invertebrates were not used as significant features because our knowledge of invertebrates was too limited to avoid making arbitrary choices about areas. However, comprehensive knowledge about the invertebrate fauna of Illinois caves has been summarized by Peck and Lewis (1978); and after some more fieldwork, it was possible to confidently list the caves with the most outstanding invertebrate faunas.

Another relatively large group of unique features includes sites with unusual assemblages of plants. These are unusual habitats with disjunct species, but they do not qualify as Category III sites under the Inventory's definition. However, scientists agree that such sites are valuable and should be listed in the inventory.

An area might be considered "unique" if it is the only undisturbed example of a particular natural community, but such areas were included

in the regular Category I survey rather than considering them as Category VI significant features.

Results

Thirty Category VI significant features were found in 29 areas. They can be summarized as follows, with the number of occurrences in each group:

Unique ecological features	5
Unique floral assemblages	5
Outstanding invertebrate cave faunas . .	13
Large bat hibernacula.	4
Other unique faunal assemblages.	3

Section 22.

CATEGORY VII SURVEY
AQUATIC AREAS

Definition and Procedure

Aquatic areas include streams and lakes, which were not evaluated as part of the Category I survey. Vegetated ponds and natural wetland communities were evaluated by the Inventory staff and were included as Category I areas, but streams and lakes were inventoried as Category VII features.

The Illinois Natural History Survey provided recommendations for listing outstanding streams and lakes, based on years of accumulated data and experience with the natural waters of the state. Smith (1971, 1973) and Evers and Page (1977) of the Natural History Survey summarized information about outstanding aquatic areas in Illinois and gave their criteria for recognizing significant sites.

Dr. Philip W. Smith and Dr. Lawrence M. Page of the Illinois Natural History Survey compiled a list of candidates for outstanding natural aquatic areas. They listed 30 sites or groups of sites, almost all of which were included as Category VII sites or in other categories.

Results

Seventeen areas with outstanding lakes or streams were included in the inventory. The five lake areas include Illinois Beach State Park and glacial lakes in Lake County, as well as backwater lakes along the Mississippi and Illinois rivers. The 12 stream segments, totaling about 210 miles, range from the Rock River and Apple River in northwestern Illinois to Big Creek and Lusk Creek in the southeastern corner of the state. However, large parts of the state, particularly western Illinois and (except for the Embarras River) south-central Illinois, have no Category VII streams.

Section 23.
LITERATURE SURVEY

John White and Donna Evans

Purpose

A literature review was conducted to (1) find articles useful for developing survey procedures and classification systems, (2) learn about natural areas that were not previously known, and (3) compile a bibliography of literature pertaining to sites listed by the Inventory.

The usefulness of the literature review proved to be as follows: (1) The survey of published works was an integral part of developing inventory techniques and classification systems. (2) Except for a few endangered species sites, no natural areas were identified solely as the result of the literature search: although many areas were cited in publications, they were readily identified through other means. (3) Some publications provided information that was of immediate value to the Inventory, but the bibliography should be more useful to future researchers than it was to the Inventory. The bibliography should help researchers choose sites and topics for further study. Scientific studies increase the preservation value of a natural area, and the studies themselves are more valuable if they are done in areas that have had previous studies.

Procedure

The literature review required about 1,000 hours of searching, conducted in the following stages.

Selecting the literature sources.--Periodicals were chosen that would give a high return of articles from a wide variety of disciplines. About 25 journals were chosen for thorough review.

Reviewing the publications.--It usually was most efficient to scan the table of contents of each volume, looking for key subject words. Using the table of contents was almost always faster and more accurate than using the subject index. Articles with promising titles in the

table of contents were searched for references to natural areas or other useful information. All articles about the ecology of Illinois or neighboring states were recorded. This method was more efficient and effective than using indices such as Biological Abstracts.

Computer search.--The computer services of the Library and Information Retrieval Research Laboratory at the University of Illinois was employed to find articles written after 1970. This computer retrieval service uses Biological Abstracts, Comprehensive Dissertation Abstracts, and Science Citation Index. Citations were retrieved by using a list of subjects (fauna, cave, glade, etc.) and a list of place names (Illinois, Iowa, Indiana, etc.); the computer retrieved articles with keywords that overlapped from both lists. This computer system had some shortcomings: (1) not all relevant keywords could be anticipated; (2) some keywords had more than one meaning, so irrelevant citations were retrieved; (3) many known articles were not retrieved, creating doubts about the completeness of the database and the effectiveness of the search; and (4) each promising article had to be read individually instead of being read as part of the regular review of periodicals. The search service retrieved 2,152 citations; 56 pertained to natural areas, and all but 15 of these were also found by the regular literature review.

Graduate theses.--Every academic unit that has a graduate degree program in biology, ecology, geology, or related subjects in Illinois was asked for a list of Master's and Ph.D. theses. Most departments did not respond or reported that they had no such list.

Bibliographies and reference lists.--Several published bibliographies were searched for references to natural areas. The most important general bibliographies for Illinois are by Vestal (1934), Isfort (1949), and Pemble, et al. (1975). The literature cited in many articles led to new references.

Natural Area Bibliography

Summary

The bibliography of Illinois natural areas covers 1,484 titles. This includes 1,413 references to biology and ecology and 71 references

to geology. About half of the natural areas (527 out of 1,089) have published references. The 10 natural areas with more than 40 references are as follows (with the number of citations for each):

Trelease Woods (Champaign Co.)	213
Allerton Park (Piatt Co.).	164
Pine Hills--LaRue Swamp--Wolf Lake (Union Co.)	143
Illinois Beach (Lake Co.).	97
Brownfield Woods (Champaign Co.)	79
Giant City (Union and Jackson cos.).	61
Starved Rock (LaSalle Co.)	59
Horseshoe Lake (Alexander Co.)	51
Heron Pond--Wildcat Bluff--Little Black Slough (Johnson Co.)	48
Lusk Creek (Pope Co.).	43

In addition to citations for areas listed by the Inventory, approximately 3,500 other references about field biology, ecology, and inventory techniques were compiled. About 1,700 of these pertain to Illinois, and about 1,300 refer to other Midwestern states.

References to geology

Relatively few references to geology were selected for the bibliography because they were included only for geologic areas. Although each geologic area might have an average of five or more important articles, usually one reference that cites previous publications was included. Geologic references were not compiled for all natural areas because literature about Illinois geology through 1965 has been indexed in a bibliography by Willman, et al. (1968). This bibliography includes about 4,400 publications by the staff of the Illinois State Geological Survey, and it lists about 400 graduate theses.

References to biology and ecology

The 1,413 references other than geology papers can be placed in the following groups:

Detailed scientific references.--Describe a feature or features of one or more natural areas, giving detailed information about the site. Examples: Klimstra (1969), Lindsey (1962), and Park, et al.

(1953) . . . 563 articles.

General scientific references.--Results of studies that relied on collections and observations in several sites, including one or more natural areas. Examples: Pepoon (1927*a*), Smith and Parmalee (1954), and Zetek (1918) . . . 430 articles.

Incidental scientific references and brief notes.--Results of studies that were based on observations or collections from a natural area, but that could probably have just as well been based on some other area; and brief notes about a feature in a natural area. Examples: Hoffmeister and Grebner (1948), Lord (1959), Schanzle (1973), and Zar (1968) . . . 174 articles.

Preservation articles.--Promoting the preservation of areas, describing preservation efforts, listing areas that are preserved, and lamenting the destruction of areas . . . 113 articles.

Popular articles.--Mostly about state parks. Examples: Malkovich (1962) and Mohlenbrock (1971) . . . 102 articles.

Publications relating to the use of areas.--Management and development plans, historical and archeological accounts, and visitor guidebooks . . . 31 articles.

Articles from newspapers and newsletters were included in the natural areas bibliography only if they had important information not available in other publications. Many important studies were excluded because the authors mentioned no specific natural areas. Some studies, especially old ones, were not included because the study area was not named or described well enough to be identified.

Sources of publications

The biology and ecology references came from the following sources (with the number of references from each source):

Scientific periodicals	774
Books, special publications, and reports	215
Newspapers, magazines, and periodicals of conservation groups	206
Master's theses.	172

Ph.D. dissertations. 36

Other graduate student research papers 10

The 774 articles in scientific periodicals came from 119 different series of periodicals. The following journals have the largest number and variety of papers about the ecology or biology of natural areas: *Transactions of the Illinois State Academy of Science* (with 237 articles), *American Midland Naturalist* (63 articles), *Ecology*, and *Ecological Monographs*. Also, the *Bulletins* and *Biological Notes* of the Illinois Natural History Survey have 38 articles that mention natural areas.

The most prolific sources of popular articles about natural areas are *Illinois* magazine (formerly *Outdoor Illinois*, with 78 articles), *Illinois Audubon Bulletin* (75 articles), and *Field Museum of Natural History Bulletin* (17 articles).

Although a broad representation of disciplines was sought, there were more articles about botany than any other subject referring to specific natural areas. Papers on the botany of natural areas are most common in *Rhodora*, *Botanical Gazette*, *American Fern Journal*, *Castanea*, *Bryologist*, and *Mycologia*. There are many studies about birds in *Wilson Bulletin* and *Auk*, and several natural areas are included in breeding-bird censuses and winter bird-population studies in *American Birds* and *Audubon Field Notes*. Other papers about vertebrate zoology are most often found in *Journal of Wildlife Management*, *Herpetologica*, and the *Natural History Miscellanea* of the Chicago Academy of Sciences. Most papers about invertebrate zoology in natural areas appear in the *Transactions of the American Entomological Society* and *Illinois Natural History Survey Bulletin*.

Dates of publications

Early descriptions by non-scientists.--The earliest descriptions of Illinois' natural landscape do not often have recognizable place names. Unless the site was described in detail or is a prominent landmark, it is rarely possible to identify specific natural areas in the earliest writings. French explorers described sites along major rivers; but other than the notes of the Federal land surveyors, the earliest reference that was found is the journal of Colbee C. Benton, who visited Indians in the Chain O'Lakes region in 1833. He described landmarks now

known as Cedar Lake, Grass Lake, and Elizabeth Lake (Angle and Getz, 1957). Beginning in the 1830's there were several booklets and articles in Eastern magazines that described the economic potential of the Illinois landscape. Examples include the booklet by the Illinois Central Rail-Road (1856) and others listed by McManis (1964), Poggi (1934), and Krohe (1978).

Early publications by naturalists.--The earliest known publication in which a naturalist described sites listed by the Inventory is a reference to Bald Knob (Union Co.) and Equality Cave (Saline Co.) by Andrews (1860). There are earlier important publications, but they do not describe specific natural areas. For example, Kennicott (1855, 1857) discussed the animals of Illinois, and Short (1854) described the prairies. Engelmann (1863) described some natural communities of southern Illinois; and similar articles appeared in two series of books edited by A. H. Worthen, entitled the *Geological Survey of Illinois* and *Economical Geology of Illinois*, beginning with the first volume by Worthen (1866).

Publications in this century.--Sixteen articles about natural areas are known from the 1800's, but most are from this century. The Inventory found pertinent articles published in every year since 1901. Figure 1 shows the rapid increase in the literature about natural areas, which has coincided with the development of the science of ecology. The number of publications has roughly doubled every 20 years, apparently unaffected by economic conditions except for a decline during World War II. The relatively large number of publications listed for the last 20 years is influenced by the current availability of special reports that will become scarce once they are out of print, but this hardly begins to account for the tremendous increase in natural areas literature beginning about 1960. Part of the increase can be attributed to the National Environmental Policy Act, which requires studies of the environmental impact of certain proposed development projects, but much literature is the result of an increase in environmental awareness and an increased understanding of the value of natural areas for research. Over 200 articles have been written about Illinois Nature Preserves since 1964, when the first nature preserve was dedicated. One hundred and five permits have been issued since

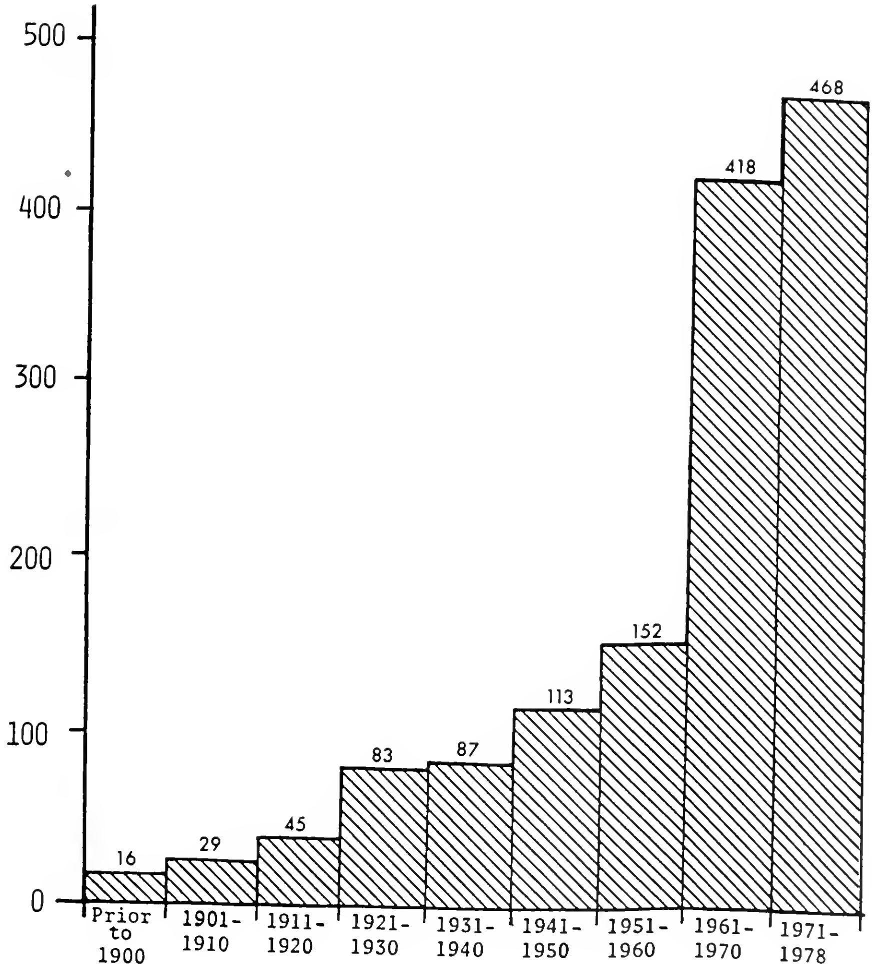

Figure 1. Number of references to natural areas published in each decade. The graph shows the number of articles published in each 10-year period, not the cumulative total from previous decades. Geologic references are excluded from the figure.

1973 for research projects in Illinois Nature Preserves, including 40 permits in 1977 (Illinois Department of Conservation, 1978).

PART V
RESULTS AND CONCLUSIONS

The results of the project are summarized in Part V. Survey methods are evaluated, and major characteristics of natural areas are described. Activities are suggested for using and updating the results of the inventory.

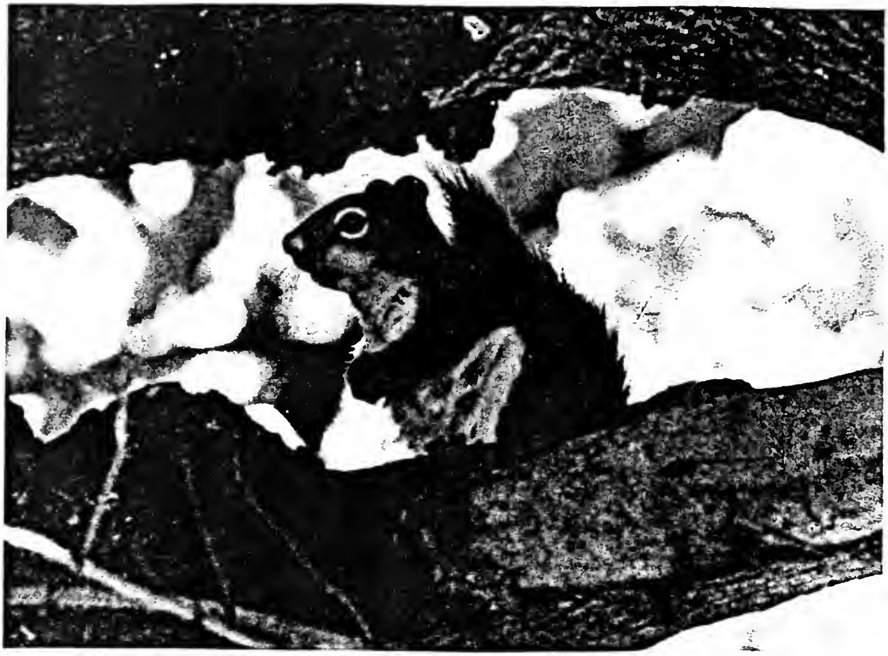

Plate 7. *A red squirrel along the Kankakee River. This species, also known as the pine squirrel, was thought to have been eliminated from the state shortly after 1900. Investigations by the Inventory staff revealed that the red squirrel inhabits at least four northern Illinois counties.*

Section 24.
EFFECTIVENESS OF THE METHODS

Introduction

This section analyzes the effectiveness of various sources of information for identifying natural areas. Both compiling available information and conducting new surveys are necessary for an adequate inventory. Because a partial inventory can be done by compiling only the existing information, an estimate is made of the number of areas that would have been found if the project had stopped at this stage. The number of areas that may have been overlooked despite all efforts is also discussed.

Finding Significant Features

Comparison of methods

The next several paragraphs are based on a study of the way in which each Category I, II, and III significant feature was found. No useful comparisons can be made with Category IV, V, and VII features because the surveys of these sites relied almost solely on existing information. Too few Category VI sites were identified to allow a useful analysis.

The following tabulation analyzes the number of areas that would have been found--or would have been missed--if the Inventory had relied solely on accumulating the existing information about natural areas, without new surveys (such as examining aerial photos, etc.):

	Cat. I	Cat. II	Cat. III
A. Number of significant features that could have been found by compiling available information:			
1. Number that could have been found only by compiling available information.	60	403	13
2. Number that could have also been found by new surveys.	235	32	23
B. Number of significant features that could have been found only by conducting new surveys . .	394	86	9
TOTAL significant features, found by all methods.	689	521	45

The above figures are broken down in the following three tabulations to show the actual or potential source of information for each area.

For significant features that could have been found only by compiling available information (line A-1 above), the source was:

	Cat. I	Cat. II	Cat. III
Contacts with people	27	156	8
Unpublished files, herbaria, etc.. . . .	23	173	4
Review of literature	10	74	1

For significant features that could have been found either by compiling available information or conducting new surveys (line A-2 above), the source could have been either:

	Cat. I	Cat. II	Cat. III
Compiling available information:			
Contacts with people.	27	14	20
Unpublished files, herbaria, etc. .	206	18	3
Review of literature.	2	0	0
Or, conducting new surveys:			
Maps and aerial photos.	193	3	16
Aerial survey	23	1	4
Ground survey	19	28	3

For significant features that could have been found only by conducting new surveys (line B above), the source was:

	Cat. I	Cat. II	Cat. III
Maps and aerial photos	290	1	1
Aerial survey.	81	3	4
Ground survey.	23	82	4

In the above analysis, compiling available information was given priority over conducting new surveys. That is, if it would have been possible to find an area by compiling available information, then the area was counted as such--even though the area may actually have been found by examining aerial photos or other means. The next tabulation shows how effective each method would have been if it were the only method used. Significant features that could have been found by either method are counted twice in this summary.

	Cat. I	Cat. II	Cat. III
Significant features that could have been found by:			
Relying on previous information only	295	435	36
Relying on new surveys only . . .	629	118	32

Adequacy of available information

The information gained from available sources is often not adequate for determining whether an area is significant. The following analysis applies to significant features that could have been found by compiling existing information:

	Cat. I	Cat. II	Cat. III
Would not have required fieldwork to check significance.	200	381	23
Would have required fieldwork to check significance.	95	54	12

This tabulation includes only significant features that were actually listed by the Inventory. If the project had relied solely on past work without checking sites to learn whether they were significant, then many sites would have been included that do not qualify as natural areas. Less than half of a list of 500 potential natural areas compiled from the files of researchers and natural resource agencies qualified as sites of statewide significance. If the Inventory had accepted this information without further investigation, about 260 areas would have been included that did not qualify in the inventory.

The value of current information based on field surveys is illustrated by the inventory of hill prairies. Dr. Robert Evers published *Hill Prairies of Illinois* (Evers, 1955), based mainly on fieldwork in 1950 and 1951. He described 61 hill prairies and limestone glades, most of which were relatively undisturbed. The Inventory recognized 16 of these 61 sites as natural areas, and added 102 more areas with natural hill prairies or limestone glades. Dr. Evers' classic, pioneering work was completed 25 years ago, and he found most sites by driving along river bluffs. The Inventory relied on maps, aerial photos, and aircraft, followed by ground checks. The Inventory staff discovered many more hill

prairies and learned that some that were significant in the 1950's had succumbed to woody invasion and grazing.

Published natural area studies do not necessarily include areas of statewide significance, because the studies use different criteria. Two recent county inventories (Wilhelm, 1978; Bell and Zales, 1977) included a total of 63 areas, but only 34 of these sites were listed by the Inventory. Without investigations beyond a literature review, the staff would not have known whether some of the sites met the Inventory's criteria.

Surveys of individual counties are likely to include areas that are not of statewide significance, but an inventory of nationally significant areas should not include any areas that are not of state significance. Shepard and Boggess (1971) and Goodwin and Niering (1975) compiled lists of sites in Illinois recommended for possible registration by the national Natural Landmarks Program. They included 10 forests, prairies, and wetlands--by compiling information available from literature, people, and agencies. Three of these 10 sites did not meet the Inventory's criteria as ecological areas of statewide significance, and the Inventory found 50 additional sites that probably would have exceeded the minimum standards for the previous studies.

Aside from the problems of overlooking significant areas and mistakenly including areas that are not significant, an inventory that omits field surveys is limited by the uneven amount of information available for different areas. A bare minimum of information for all areas can be considered uniform as a basis for making comparisons.

Screening Potential Natural Areas

The previous tabulations dealt with the numbers of significant features that were actually identified by the Inventory. This revealed how effective each of the inventory methods was for producing the end results. The following tabulations consider the methods from a different point of view, by analyzing how effective each of the inventory methods was as a practical means of finding and screening potential natural areas.

The following analysis is based on 1,000 potential natural areas from 33 randomly selected counties. The figures in the tabulation have been divided by 10 and (usually) rounded to whole numbers so that the numbers can be read as percentages. Only areas with potential Category I significant features were considered, and the cemetery survey was excluded because of its unusual methods. The inventory methods are condensed into four stages: (1) compiling available information (reviewing literature, contacting people, etc.), (2) examining maps and aerial photos, (3) aerial surveys, and (4) ground surveys (including initial ground survey and final field survey). Each of these four stages is treated in a separate tabulation as a source of potential natural areas, and the following figures are given for each: (1) total number of natural areas considered, (2) number of sites that qualified as natural areas, (3) number of sites out of the total that were rejected by each of the inventory stages.

Source: Available information

Compiling available information had one of the highest rates of return (38%) in terms of the number of natural areas identified for the number of potential natural areas considered. A high percentage of the areas identified from existing information consisted of Illinois Nature Preserves and other well known natural areas.

Percent of areas considered	13
Natural areas identified	5
Potential natural areas rejected, by:	
Available information	1
Maps and aerial photos	1
Aerial survey	2
Ground survey	4

Source: Maps and aerial photos

Examining maps and aerial photos produced 73% of the potential natural areas, and 62% of these were quickly screened by the aerial survey. About one out of 15 of the potential natural areas selected during the map and aerial photo examination stage actually qualified as a significant natural area.

Percent of areas considered	73
Natural areas identified	5
Potential natural areas rejected, by:	
Available information	1
Maps and aerial photos	5
Aerial survey	45
Ground survey	17

Source: Aerial survey

About two-thirds of the potential natural areas selected by the aerial survey were potential railroad prairies. One out of 11 of the potential railroad prairies qualified as a natural area. Most of the other sites found during the aerial survey were hill prairies.

Percent of areas considered	13.5
Natural areas identified	1.4
Potential natural areas rejected, by:	
Available information	0
Maps and aerial photos	0
Aerial survey	0.1
Ground survey	12

Source: Ground survey

Less than 1% of the potential Category I natural areas were found by ground surveys unsupported by previous investigations.

Percent of areas considered	0.4
Natural areas identified	0.2
Potential natural areas rejected, by:	
Available information	0
Maps and aerial photos	0
Aerial survey	0.1
Ground survey	0.1

Importance of Experience

Experience was an important factor in determining work efficiency. With practice, the fieldworkers became proficient at aerial surveys and at map and aerial photo examination techniques. Time was saved in two ways: (1) As the ecologists became familiar with procedures, they worked more quickly. (2) More importantly, in the early part of the survey fieldworkers chose potential areas of questionable value to avoid over-

looking significant sites. After the staff had checked enough sites on the ground, they learned how to increase selectiveness but still have a reasonable margin of safety.

For example, during the second year of the Main Survey, a larger proportion of the forested areas were rejected by examining old aerial photos. The staff had learned that if a forest had a long history of heavy grazing, it would not recover to a natural structure and composition even after 20 years of protection. If a forest had a natural-appearing canopy on a recent photo, but examining a series of photos from the 1930's through the 1950's revealed that the forest had been heavily damaged by grazing, then it was safe to reject the area.

During the second season's aerial survey, it seemed more difficult to evaluate many forested tracts. Usually the evaluation was either instantaneous--the forest had recently been logged or cleared--or it was difficult to determine from an airplane whether the forest had been disturbed. The fieldworkers had become so proficient at studying aerial photos that it was difficult to see any more disturbance from an airplane unless the disturbance had occurred after the photo was taken. Increased proficiency at aerial surveying is demonstrated by the fact that many of the sites selected during the early part of the aerial survey of railroad prairies were obviously insignificant to the fieldworkers when they flew along the same tracks at a later time.

Completeness of the Inventory

Category I survey

The staff was able to quickly screen potential areas and concentrate on describing and evaluating the most significant sites. All of Illinois was studied with maps and aerial photos. Every site found with significant potential for undisturbed natural communities was examined in the field. For example, all river valleys were checked for hill prairies and seeps. All open land on sandy soil in prairie regions that was not obviously disturbed was checked for sand prairie. All railroads and all cemeteries that could be found in prairie regions were checked for prairie remnants. Every tract of timber of 20 acres or larger with a natural-

appearing structure was selected from aerial photos and checked in the field. All wetlands were studied on maps and photos, from an airplane, or on the ground.

It is difficult to estimate what may have been missed. The field-workers eliminated the obviously disturbed areas and checked the remainder. The relatively large number of potential natural areas that were eliminated during the screening process indicates that preliminary standards were low enough that few significant sites were overlooked. Considering that 88% of the potential natural areas did not qualify as natural areas, it is unlikely that many undisturbed areas were overlooked.

The number of sites that would have been missed if the available information accumulated through the years about natural areas had been completely ignored gives some idea of the thoroughness of the Category I survey: 60 out of the 689 Category I significant features probably would have been missed. This includes 22 caves, 14 prairies, eight seeps, and two forests. The remaining 14 sites include barrens, fens, bluffs, overhangs, and a pond.

The high percentage of caves identified by existing sources is because there was little searching for caves beyond what was necessary to check the significance of ones that had already been identified as important. Although caves were considered to have Category I significant features just as any other kind of natural community, the Inventory relied on information for about 300 caves compiled by the Illinois Speleological Survey. Work by the Speleological Survey, by Bretz and Harris (1961), and by Peck and Lewis (1978) shows that the most outstanding cave ecosystems are usually the caves that are large and generally well known.

Eight of the 29 seeps listed as significant features would not have been identified if available information had been ignored. This is a high ratio because many of the seeps are small (some less than one-tenth acre) and the small ones are not always evident on maps, aerial photos, or from an airplane.

The Category I significant features that have been overlooked are most likely small natural communities or remnants that cannot be found

by conventional map, aerial photo, and aerial survey techniques. In over a year since the survey to find Category I natural areas ended, information from others has added three more areas: two seeps and one eroding bluff. Two possibly significant prairies have also been reported. Only time will tell how many new areas will be discovered, but most of the areas that were missed probably will remain unknown. In terms of total acreage of Grade A and B significant features, the inventory probably is close to complete.

Category II survey

Much work remains to be done with endangered species. Even though the Inventory listed 1,431 occurrences of the species considered in the Category II survey, no natural areas were identified for 18% of the animals listed as endangered or threatened by the Endangered Species Protection Board and 26% of the plants listed by the Endangered Species Project. The Inventory's contract with the Department of Conservation required only a compilation of available information for the endangered species survey, but field surveys were conducted when possible to add new sites and to confirm previous reports. The staff helped the Endangered Species Project organize information from other sources, but in some cases the Inventory did little more than identify large gaps in the knowledge about the state's flora and fauna.

Category III survey

The inventory of Category III significant features probably was thorough. Relatively few new sites met the Inventory's criteria. The significant ones were almost always in extreme sites that had already been investigated because they were so obvious. Many other sites that had less potential were searched to assure that initial selection standards were liberal enough to avoid overlooking sites.

Category IV survey

The geologic areas were chosen to make a system of sites representing the geologic features of Illinois. Some areas are obviously the best choices for representing certain features; but in many cases, any one of several sites could have been chosen. Depending on the emphasis given to

the different kinds of geologic features (rock outcrops, landforms, fossils, etc.), other sites could have been listed.

Category V survey

The survey of school natural areas and nature preserves relied on compiling available information, especially a mailed questionnaire survey. A response was requested from every school, even if the school used no natural area, and a 52% response was received from elementary and secondary schools--which is creditable by some standards but was not satisfactory for a survey that emphasized thoroughness. Persistence in contacting people allowed a nearly complete coverage of colleges and universities. However, at least 40 more areas are known that would probably qualify as Category V areas if enough information about them could be obtained.

Category VI survey

The Category VI significant features are unique features that did not fit in any of the other categories. Thirty such significant features were listed, and a few more may eventually be added. If the Department of Conservation decides to list areas outstanding because of their invertebrate fauna or nonvascular flora, then this natural area category could be greatly expanded or another category could be added.

Category VII survey

As described in Section 22, the Inventory listed only lakes and streams that were recommended by the staff of the Illinois Natural History Survey. The Survey listed areas that, based on studies of aquatic fauna, are exceptionally outstanding and in need of preservation. Other lakes and streams of lesser significance could have been added, and new field surveys specifically to evaluate the natural quality of lakes and streams might reveal other significant sites.

Summary

All of the inventory methods were necessary to complete a comprehensive natural areas survey. Compiling available information was a basic step; but, except for most endangered species occurrences, this information was often too incomplete to determine whether a potential site qualified as a natural area. Examining maps and aerial photos revealed

most of the Category I significant features but revealed relatively few endangered species sites. Studying maps and photos assured that the search was systematic and thorough, and it provided a large number of potential natural areas at a low cost. Most of the candidate areas were screened with an aerial survey, which was quite effective: the aerial survey cost less than one-twentieth of the total survey budget, and screening sites without an airplane would have taken seven to 10 times as much time and money. Also, many significant natural areas could have been overlooked without the aerial survey. Almost no natural areas were discovered during ground surveys unsupported by the previous inventory stages such as examination of maps and aerial photos. Within the limitations set by the Department of Conservation's guidelines, the surveys were as thorough as practical. The most likely categories for finding new areas in the future are the kinds of areas for which the Inventory relied on available information.

Section 25.
SUMMARY OF NATURAL AREA CHARACTERISTICS

Number and Distribution of Natural Areas and Significant Features

Number and distribution by county

Figure 2 shows the total number of significant features that occur in natural areas in each county. This information is summarized in Table 4. Sites were recognized in all but three of the 102 counties. Natural areas with high quality communities were found in all but eight counties. Sixty-one counties have endangered species sites, 15 counties have relict species sites, and 56 counties have geologic areas. There are nature preserve and school natural areas in 76 counties, unique natural areas in 20 counties, and outstanding aquatic areas in 17 counties. The average county has 10 or 11 natural areas. Eight counties have over 30 areas: Cook, Lake, Pope, Will, Winnebago, McHenry, Johnson, and Union.

Number and distribution by Natural Division and Section

Table 5 gives the number of natural areas and significant features in each Natural Division and Section. The factors that have influenced the number of natural areas in the different natural regions of the state are discussed below.

A broad but uneven distribution of natural areas

One of the best ways to see how natural areas are distributed is to study their location by topographic quadrangle, because the quadrangles form a regular grid, as opposed to the irregular sizes and shapes of counties. Two hundred and eighty-nine 15-minute topographic maps cover Illinois, including about 80 maps that cover only part of Illinois because they extend into another state. There are natural areas in 226 (78%) of these quadrangles (Figure 3).

In general the sites are clustered, and large parts of the state are nearly devoid of natural land. The sites often occur in lines, such as several prairie remnants along the same railroad track--the only undisturbed land in the county. Other prominent lines of natural areas

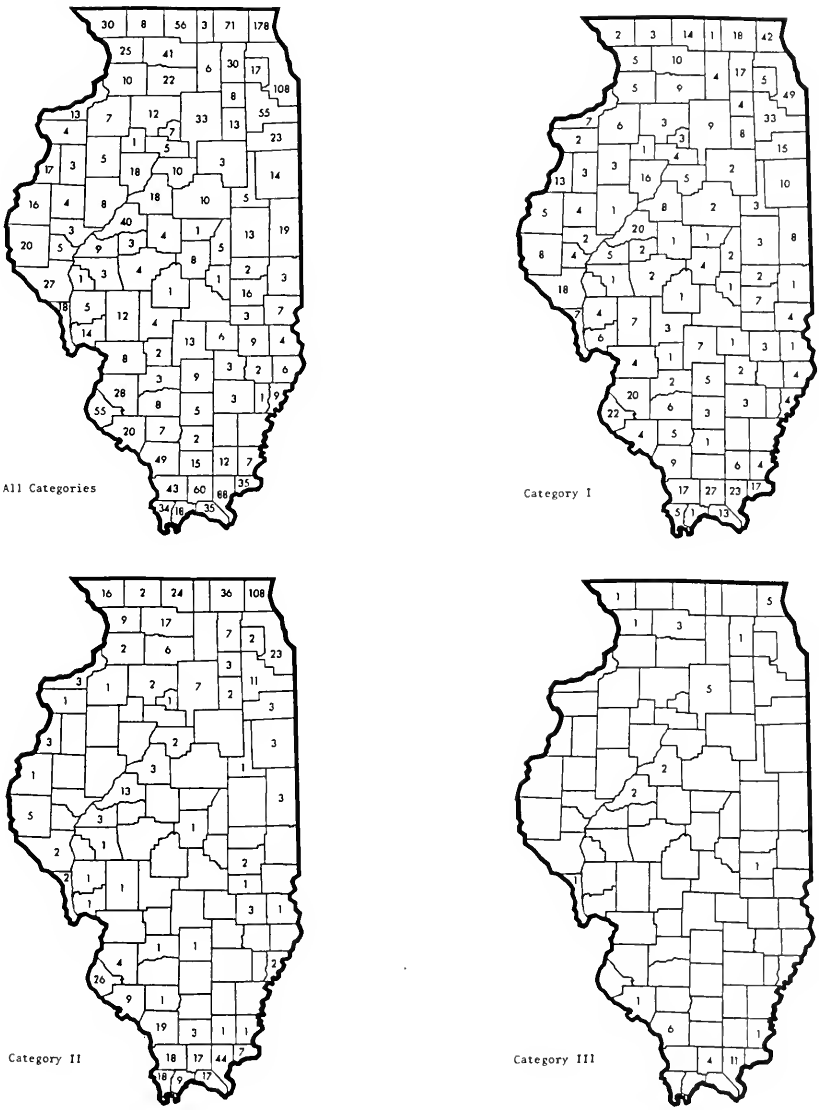

Figure 2. Number of significant features (by category) in each county.

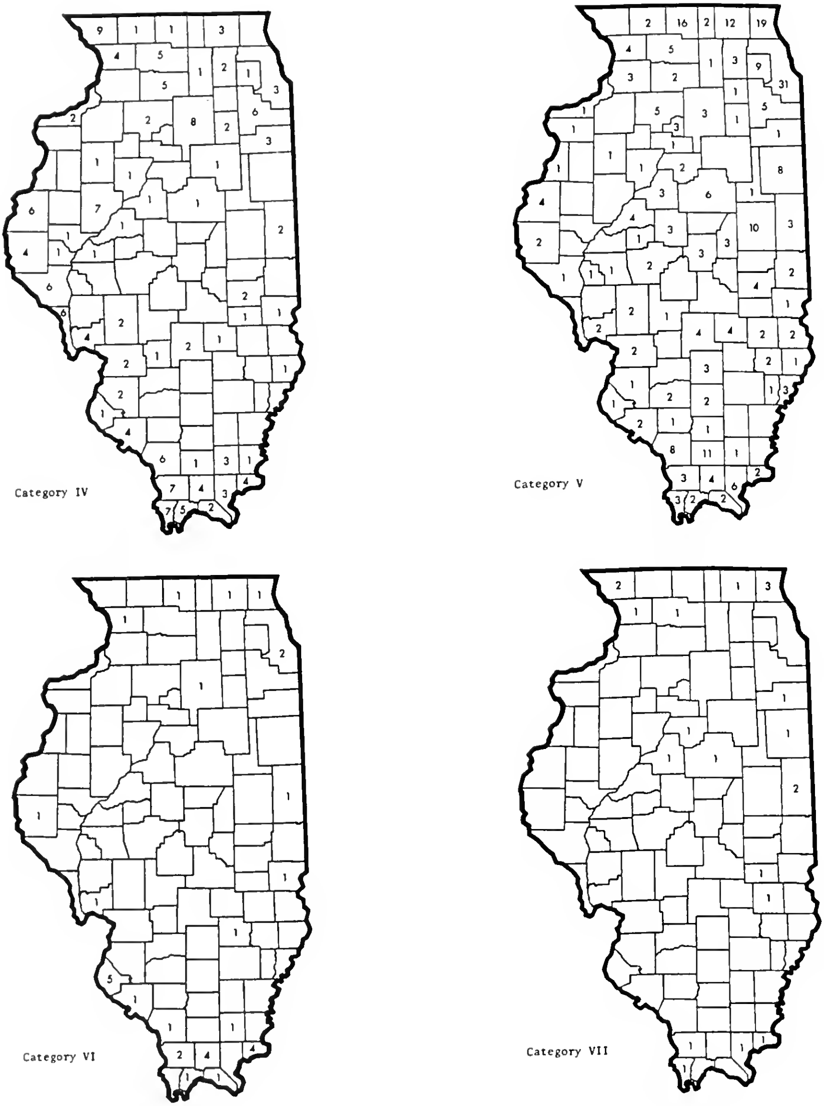

Figure 2. Number of significant features (by category) in each county, *continued*.

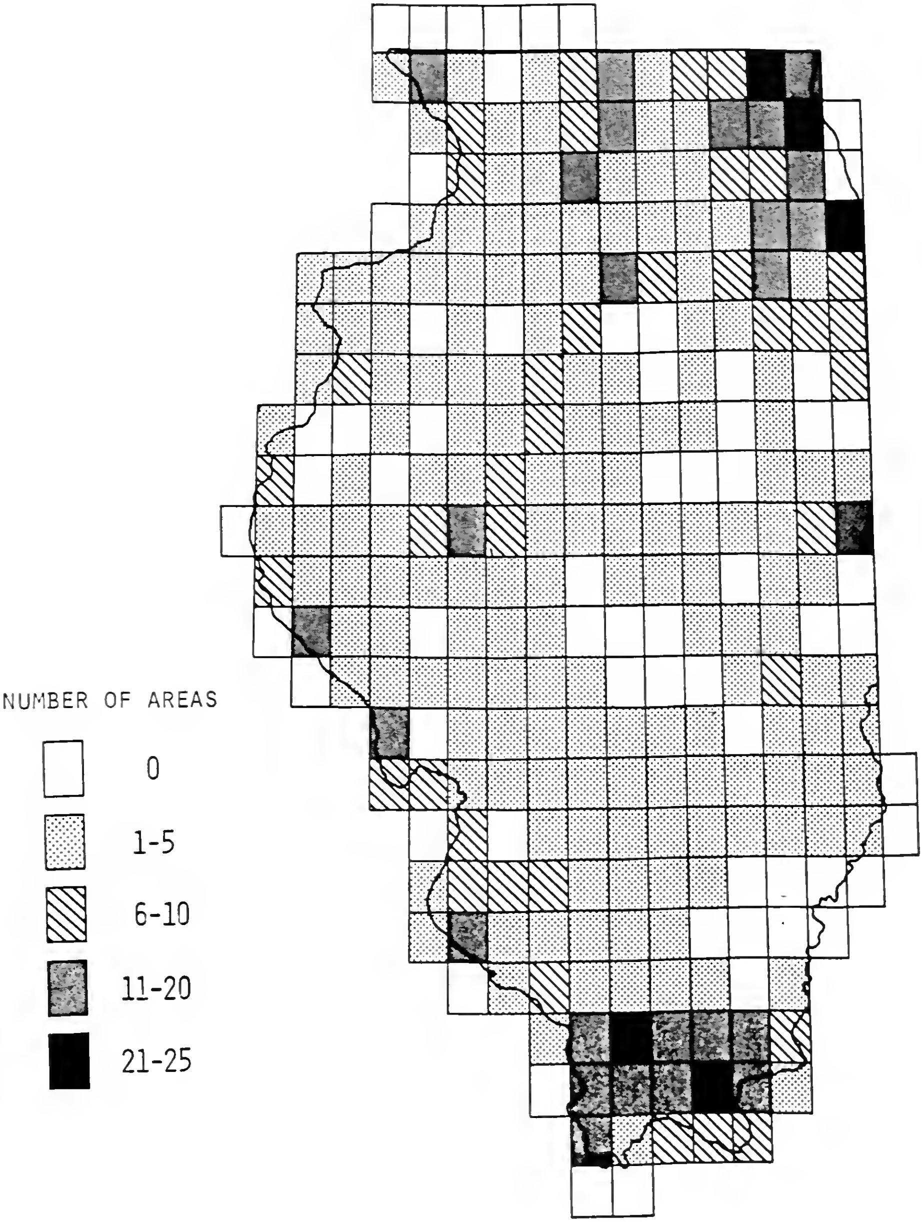

Figure 3. Distribution of natural areas according to 15-minute topographic quadrangles.

occur on river bluffs, especially in Pike and Monroe counties, where hill prairies are common atop the high, southwest-facing cliffs. Hill prairies are also clustered in the steep side valleys that form where the Illinois and Embarras rivers cut through high glacial moraines. Natural areas of all kinds are clustered around cities, where public parks and preserves have protected and restored the natural landscape. On the broadest scale, natural areas are absent from the flat prairie land that is almost completely farmed.

Over half (52%) of the natural areas occur within 15 miles of the boundaries of the state. One reason is that many undisturbed sites are on the rugged bluffs and undrained bottomlands along the rivers that form the western and southern boundaries of Illinois. Similarly, many geologic areas were selected on these river bluffs and in the Coastal Plain sediments that barely enter southern Illinois. The large number of endangered species sites in extreme southern Illinois is partly fortuitous: if the state did not extend so far south, these southern species would not be in the state at all; and if Illinois extended much farther south, some of these animals and plants would be so common within the state's boundaries that they would not be considered endangered. The situation is similar in northern Illinois, where many plants that are common not much farther north barely extend into wetlands in the northern tier of counties. The limestone bluffs and ledges along the Mississippi River on the southwestern border of Illinois provide habitat for several western animals and plants that range no farther into the state. The distribution of Category I natural areas is tied to land use patterns, as discussed in Section 26.

Distribution in relation to human population

Natural areas are most concentrated in the counties with population extremes. The four most populous counties (Cook, DuPage, Lake, and Will) rank first, twenty-seventh, second, and fourth, respectively, in number of natural areas. Pope County, the least populated county, ranks third in number of natural areas. Illinois has nine Standard Metropolitan Statistical Areas (SMSA's), which are counties or groups of counties with population centers of at least 50,000 people. (For example, Sangamon

County is the Springfield SMSA, and Winnebago and Boone counties form the Rockford SMSA.) There are 359 natural areas inside the SMSA's, which means that nearly one-third of the sites identified by the Inventory are in or very near major population centers. One hundred and seventy-one natural areas (11%) are wholly or partly within the corporate boundaries of cities, towns, or villages, and half of these natural areas have Category I significant features.

Natural Characteristics

Acreage

Natural areas average 184 acres and range from less than 0.1 acre to 13,100 acres. The smallest are sites with endangered or relict species, and the largest areas encompass cave systems and habitats of river otters and greater prairie chickens. There are about equal numbers of natural areas distributed among four size classes: 0.1 to 5.0 acres, 5.1 to 25 acres, 26 to 80 acres, and 81 to 13,100 acres.

Diversity

Diversity of a natural area is defined in this project as the number of natural communities that are at least Grade C quality. The average natural area has three such natural communities, but five sites have 10 or more communities: Illinois Beach Nature Preserve (16 communities), Illinois Beach North Tract (15), LaRue--Pine Hills Ecological Area (15), the Little Black Slough--Heron Pond--Wildcat Bluff area (13), and the Apple River Canyon area (10). Areas with great topographic relief generally have high diversity: the 23 natural areas with 300 feet or more of relief have an average of six natural communities. Diversity of communities is related more to diversity of soils than to relief: Illinois Beach, the most diverse natural area in Illinois, has only 30 feet of relief and owes its diversity to the many small habitats created by alternating swales and ridges of sand.

Topography

The topographic diversity of Illinois is well represented in sites identified by the Inventory. Natural areas were recognized in all 16 physiographic units (Appendix 4) defined by Leighton, et al. (1948).

Most of the 61 major topographic features in Illinois according to the classification by Dr. H. B. Willman (Appendix 5) are in natural areas, except for a few features distinguished from others on the basis of loess thickness. Nearly all of the 64 individual topographic features (Appendix 6) were found in one or more natural areas.

Geologic formations

Appendix 7 lists the geologic formations in Illinois (Willman, et al., 1975), with the number of times each formation occurs at the surface in a natural area. One hundred and twenty-seven (or 89%) of the 143 named formations in Illinois occur in sites listed by the Inventory. The percentage is high because geologic areas were listed to include most of the formations in Illinois, but 68% of the formations occur in Category I areas alone.

Soil associations

Soil associations were recorded for 827 natural areas (Appendix 8). The prairie soils have the fewest remaining natural areas. For example, the Joy--Tama--Muscatine--Ipava--Sable association, a prairie soil derived from loess on glacial drift, covers 13.2% of Illinois but includes only 2.4% of the natural areas. No undisturbed natural areas were found on one of the major prairie soil associations, and some other associations were represented by only a few acres. Natural areas are most common on floodplains, sandy soil, glacial outwash, and deep loess soil in the hill country bordering the major rivers in southern Illinois.

Natural communities

The Inventory developed a classification of 93 types of natural communities in Illinois (Appendix 30). Each of these types is a distinct natural community when it occurs in a different one of the 34 Sections of the Natural Divisions of Illinois. However, not all 93 types occur in all 34 Sections--for example, there are no forested bogs in the Southern Section of the Ozark Division. At least 900 natural communities would have been recognized if an ecologist could have applied the classification system to Illinois 200 years ago. This figure undoubtedly does not count natural communities that existed in the 1700's but which have been completely destroyed or have changed so much that they can no

longer be recognized. There may have been over 1,200 communities, but our knowledge is too scant to make a firm estimate of the original number of communities. The Inventory was able to find high quality examples of about 380 different natural communities, and the natural areas include disturbed examples of 160 other kinds of communities (Table 6).

Plant communities

The Inventory used plant communities to describe natural areas; it did not classify natural areas according to plant communities. Natural communities were used instead of plant communities to classify natural areas. The distinction between plant communities and natural communities is detailed in Appendix 30. Plant communities were distinguished and named according to their dominant plants, and the order of the species names in the plant community name was determined by the order of dominance. For example, a white oak--red oak--shagbark hickory community is distinct from a red oak--white oak--shagbark hickory community. Because of this detail it is not practical to list all of the plant communities, but the species that were named most often dominants in plant communities can be listed. In the series that follows, the top nine dominants are listed with the number of times the species was dominant in a plant community:

White oak	365
Little bluestem	312
Red oak	254
Black oak	248
Sugar maple	182
Indian grass.	146
Big bluestem.	137
Post oak.	129
Silver maple.	100

Forest cover types

Appendix 9 lists the 37 Society of American Foresters' cover types recorded in natural areas. The five most frequent cover types (with the relative frequency of each) are: white oak--northern red oak--hickory (25%), post oak--black oak (14%), white oak (14%), silver maple--American

elm (9%), and northern red oak--basswood--white ash (7%).

Natural quality

Natural quality is a measure of the evidence of disturbance. A Grade A community shows very little or no effects of disturbance, and a Grade B community shows slight disturbance. The concept of natural quality is introduced in Section 7 and is explained in Appendix 22.

The Inventory attempted to find the highest quality examples of each natural community in the state. All Grade A and B natural communities were identified as significant features, except for (1) tracts that were too small to qualify, (2) most cliff and bluff communities, and (3) some streams. Since most cliffs and bluffs are relatively undisturbed, only the ones with the most outstanding natural communities were chosen. Some small streams that would rate Grade A or B were not listed in the inventory because the project relied on recommendations from the Illinois Natural History Survey to identify the few most outstanding streams in the state. If no Grade A or B examples of a particular natural community were found, a Grade C area would be included if the staff was sure that it was the least disturbed of its kind. It was rarely possible to identify any one Grade C area as the best example, because the examples were usually so generally disturbed that none was particularly better than the next. Consequently, only 23 Grade C natural communities were listed as Category I significant features.

The acreage and percentage of Grade A and B natural communities in each Natural Division and Section is detailed in Appendix 2. Illinois' natural landscape has been nearly completely altered. The acreage of Grade A and B land and water found by the Inventory is as follows:

Forests	13,484
Prairies	2,352
Savannas	1,296
Wetlands	6,029
Lakes and ponds	1,960
Primary communities	602
TOTAL	25,723

The above total is seven-hundredths of 1% of Illinois' land and water area. About 118 acres of natural prairie remain for each million acres of the estimated presettlement extent of prairie in Illinois--and this ratio is exaggerated because many of the natural prairies remaining are hill prairies that were so small and insignificant in comparison to the flatland prairies that the original Federal surveyors of Illinois did not even note them. The presettlement acreage of forest in Illinois (see King and Winters, 1952; Nixon, et al., 1978) probably was less than 14 million acres, and estimates seem to include savannas in the totals. There are an estimated 3.79 million acres of forest land in Illinois (Burde and Baumgartner, 1978). Based on this estimate, less than 1 acre of forest out of every 280 that remains is of high to very high natural quality. Figure 4 shows the fraction of each county that remains relatively undisturbed. The fractions are expressed in millionths.

Exceptional features

Exceptional features add to the value of a natural area, but are not significant enough to be the reason for identifying an area. The following numbers of exceptional features were found in natural areas:

Relatively undisturbed natural communities	300
Habitats with rare, threatened, or endangered species.	910
Habitats with relict species	26
Geologic exposures	237
Unique natural features.	20
Archaeological and historical features	43
Aquatic features	805

Ownership, Use, Management, and Protection

Type of ownership

Ownership was determined as private, public, or unknown. One natural area could have any or all of the three types of ownership (Appendix 14). Considering all 1,089 natural areas, 69% are wholly or partly in private ownership and 38% are wholly or partly in public ownership. Ownership was not determined for all or parts of 6% of the areas. The percentage of ownership types in the seven natural area categories does

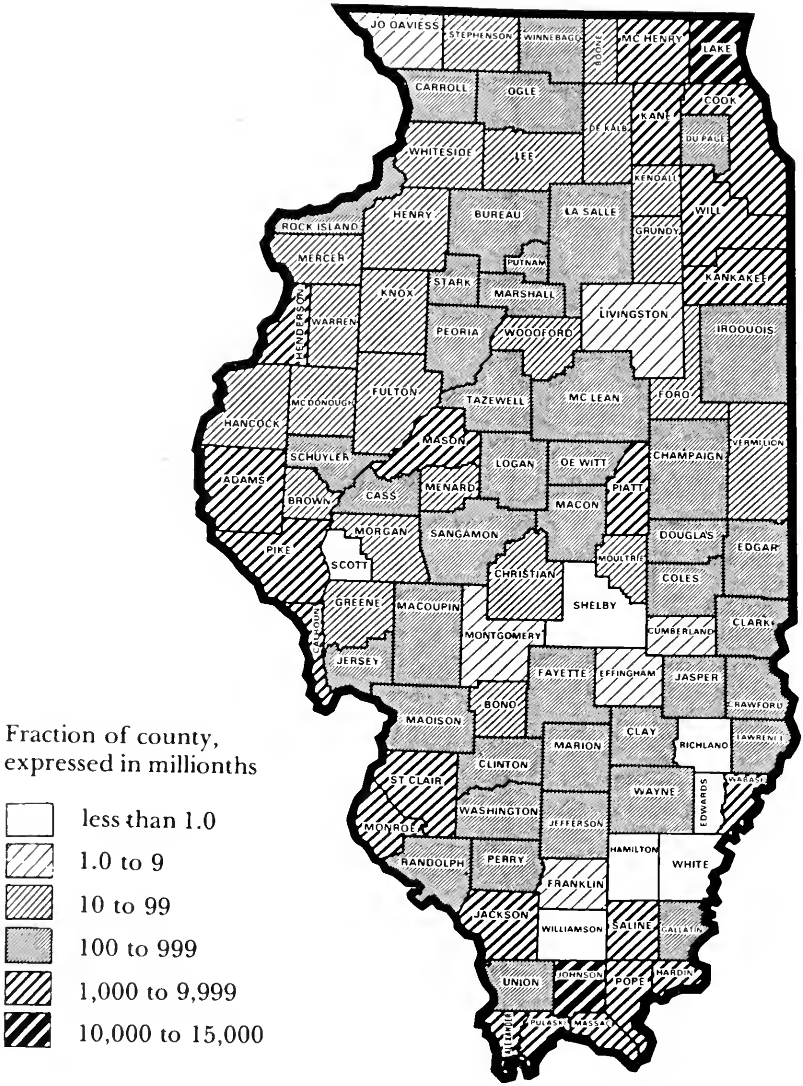

Figure 4. Relative acreage of land and water that was identified by the Inventory as undisturbed or nearly undisturbed in each county. The relative acreage in each county is expressed as a fraction, computed by dividing the acreage of Grade A & B area in the county by the total acreage of the county.

not vary significantly, except that relatively many (76%) of the Category V areas are in public ownership. Among Category I areas, the only large departure from the average is the prairie community class, of which only 20% of the areas include public ownership compared with 30% for all Category I areas.

Number of ownerships

Over half (63%) of the areas are in only one ownership, but 10% have five or more ownerships. Nineteen percent have two to four ownerships. The number of ownerships could not be determined for 8% of the areas.

Uses of natural areas

Appendix 11 gives the percentage of natural areas in 19 use categories. The most common uses are low-intensity recreation (34%) and research and education visits (23%). Thirty-one percent of the areas have no apparent use.

Use of surrounding land

The percentage of land within 1 mile of each natural area was classified according to three land use categories. These three categories, with the average value computed for all areas, are *wildland* (33%), *developed land* (16%), and *farmland* (51%). The percentages are nearly the same when computed for Category I areas alone. Comparing the above figures with the Illinois Conservation Needs Inventory (Illinois Conservation Needs Committee, 1970) shows that natural areas are surrounded by significantly more forest and wetland, but significantly less farmland, than the average for the state.

Management needs

Major management needs were noted at each natural area. The staff's analysis included a general description of the problem, a description of what part of the natural area was affected, and an estimate of the effort needed to correct or contain the problem. Management problems were identified in 76% of the areas, and there are usually one or two major problems in each area (Appendix 12). The two largest kinds of management needs, each accounting for about 27% of the problems, are: (1) control of woody vegetation and exotic species, and (2) control of overuse and abuse by people (including trampling, littering, vandalism, and theft of walnut trees).

Most management problems (81%) affect the significant features of the natural areas, and most may be controlled with one effort or with continual management, but about 15% may be practically uncorrectable or uncontrollable. The fieldworkers judged five natural areas to have management problems that may destroy the significant feature and may not be corrected with any practical measures. These sites include: (1) the only stand of native red pines in Illinois (five mature trees and one seedling on either side of a highway bridge, highly vulnerable to vandals), (2) a timber stand suffering from oak wilt, (3) two areas being destroyed by severe erosion, and (4) a forest that is being killed because of flooding from the Kaskaskia Barge Canal.

Management agencies

Because of the time and expenses involved, most active management of natural areas is by public agencies or private organizations that own or lease the tracts (Appendix 13). Two hundred and eighteen natural areas are known to be protected and managed (at least in part) by public agencies, and 92 areas are owned by railroad companies. There are 276 areas for which park districts, conservation districts, soil and water conservation subdistricts, river conservancy districts, and the Shawnee National Forest are potential managers: these tracts are within the jurisdiction of these agencies but are not owned or managed by them. The Illinois Department of Conservation is the largest owner of natural areas in Illinois, with 100 areas. In addition, 97% of all natural areas in Illinois are within 25 miles of a Department of Conservation land management facility such as a state park headquarters. Colleges and universities own or manage 41 natural areas, and there is potential for schools to manage many more sites. Twenty-one percent of the natural areas have 10 or more colleges or universities within 40 miles, and the other natural areas have an average of about four such schools within 40 miles.

Besides direct ownership and management, sites can be protected through zoning and land use planning. About half the counties have zoning ordinances, as do several townships and about one-third of the municipalities. Eighty-nine percent of the natural areas are in county or multi-county planning regions.

Preservation status

A detailed tabulation of preservation status statistics is in Appendix 14. A natural area could be in any number of seven preservation status categories. Most sites (52%) include private land, not protected by the owner or lessee. The next largest category (with 15% of the areas) includes public land, not protected by the owner or lessee. The most apparent difference among the various natural area categories is that few Category IV areas are protected: 75% are on private, unprotected land.

Threats

A detailed statistical tabulation of threats to natural areas is in Appendix 14. Threats were identified in about half of the natural areas. Geologic areas are least likely to be threatened. Areas with unique natural features are most likely to be threatened. The fieldworkers thought that no threat was likely for 40% of the Category I areas. Caves are the most likely Category I areas to be threatened. Public lands are about half as likely to be threatened as private lands.

Section 26.

DESTRUCTION AND PRESERVATION OF NATURAL AREAS

Past Destruction of Natural Land and Water

Plant communities

Natural areas are among the few places on the landscape where vegetation has never been completely removed. Even most of these sites have been badly damaged. In contrast to the magnificent forests described by Ridgway (1872*a*, 1872*b*, 1882, 1894), with trees over 100 feet tall, there is hardly a tract of any size that has not been disturbed at one time or another. Most natural areas have been disturbed, but the diversity of natural species was not lost and the areas have been able to recover.

Fauna

The loss of Illinois' native fauna is in some ways greater than the loss of the flora. Many natural areas have a rich diversity of plants, but they are too small to support natural animal populations, and they are so isolated that there is no longer a source from which species can recolonize after they are eliminated from an area. The large mammals were mostly gone from Illinois by the turn of the century, as documented by Cory (1912) and Hoffmeister and Mohr (1957). Native birds are sensitive to environmental deterioration, and they continue to decline, as publications by Graber and Graber (1963) and by Graber, et al. (for example, 1978) show. Some birds have been completely extirpated or are on the verge of disappearing from the state, as shown for prairie birds by Bowles, et al. (1978). The range maps and discussions in *Amphibians and Reptiles of Illinois* by Smith (1961) show how poorly some of these animals have fared. The Illinois Natural History Survey is cooperating with the Endangered Species Project to prepare a publication which will describe the current status of endangered vertebrates. Little knowledge has been accumulated about the function of most invertebrates in Illinois' natural ecosystems, and most likely many species are disappearing before they are studied. The insects that pollinate some native prairie plants may be almost gone from Illinois (see Betz and Lamp, 1978).

Aquatic ecosystems

Abuse and deterioration of Illinois' ecosystems has not stopped at the riverbanks and lakeshores. The knowledge about the plankton, bottom fauna, and fishes of lakes and streams gathered by the Illinois Natural History Survey has not been widely studied by the naturalists of the state, and most people are unaware of the drastic changes that have taken place beneath the water's surface.

Gunning (1963), Mills, et al. (1966), Starrett (1972), and Henderson (1977) reviewed the damaging uses that the state's waters have received, particularly the Illinois River. In 1900 the Chicago Sanitary and Ship Canal began pouring sewage into the Illinois River. Richardson (1921*a*, 1921*b*, 1925*a*, 1925*b*, 1928) documented the virtual extermination of the natural fauna that lived on the bottom of the Illinois River. The changes were drastic, immediate, and permanent. Rafts of dead snails floated down the river and piled up 1 to 2 feet deep at Peoria. Richardson described a section of the upper Illinois River in 1911 as follows:

> Its oxygen is nearly all gone; its carbon dioxide rises to the maximum; its sediments become substantially like the sludge of a septic tank; its surface bubbles with the gases of decomposition escaping from sludge banks on its bottom; its odor is offensive, and its color is gray with suspended specks and larger clusters of sewage organisms carried down from the stony floor of the polluted Des Plaines, or swept from their attachments along the banks of the Illinois. On its surface are also floating masses of decaying debris borne up by the gases developing within them, and covered and fringed with the "sewage fungus" (*Sphaerotilus natans*) and the bell animalcule (*Carchesium lachmanni*) usually associated in these waters. The vegetation and drift at the edge of the stream are also everywhere slimy with these foul-water plants and minute filth-loving animals.
>
> The normal life of the stream practically disappears in the absence of oxygen; its fishes withdraw to neighboring unpolluted waters; its mollusks, crustaceans, ordinary insect larvae and other more or less sedentary forms disappear to be replaced mainly by slime worms and *Chironomus* larvae in the sludge; and its chlorophyll-bearing plants linger only along the edges in shallow water.

He reported 31 sludge worms (Tubificidae) per square meter on the bottom of Upper Peoria Lake in 1915, and 20,400 per square meter in 1922.

Pollution had declined by the 1960's, but an intensive survey of the upper Illinois River in 1966 revealed no living mussels (Starrett, 1971); and sludge worms still provided 30% of the diet for carp in the upper river (Starrett, 1972). Introduction of carp has severely damaged the water quality, native fish fauna, aquatic vegetation, and waterfowl populations that depend on Illinois' waters. Dredging and damming of major rivers, followed by barge traffic, have brought further changes. The backwater lakes in the Illinois River bottomland were once sand-bottomed and clear. Mills, et al. (1966) estimated that half of the original 400,000 acres of backwaters along the Illinois River had been drained. Most of the remainder are rapidly filling with mud, topped with a layer of flocculent ooze.

Illinois' smaller streams have also been damaged. Sixty years of change in the fish fauna of Champaign County, which is at the headwaters of four rivers, is described by Larimore and Smith (1963). Smith (1971) listed the causes of extirpation and decimation of native Illinois fishes, in order of importance, as: (1) siltation, (2) drainage of wetlands, (3) stream desiccation due to lowered water tables, (4) competition and hybridization due to habitat changes and introduction of exotic species, (5) pollution, (6) dams and impoundments, (7) raising of water temperatures due to removal of streamside vegetation, and (8) unknown causes.

Present Destruction of Natural Areas

The following experiences of the Inventory staff show how natural areas are being affected by detrimental uses.

During the railroad prairie survey, the fieldworkers saw three stands of prairie grass being bulldozed as they flew over them. Another 3-mile stretch appeared to have high potential for prairie, but 2 weeks later it had been plowed. A fifth site, visited the day after it was sighted from the air, was being bulldozed. Yet another was plowed the day after it was sighted. It is unlikely that all these areas were high quality prairies, but they were being disturbed by railroad maintenance or plowed faster than the Inventory could check them.

In Hamilton County there was a 20 square mile tract of timber in 1952, without any road. By 1971 the timber had been reduced to a few hundred acres. The staff examined 1971 aerial photos, chose two woodlots, and checked them in 1975. One had been cleared. The other had not, probably because about two dozen oil wells were in it. After the oil wells are taken out, the remaining timber may be removed until none remains out of 20 square miles that persisted until 25 years ago. No undisturbed areas were found in this county, and none to the east in White County. In Wayne County, to the north, 20,000 acres of timber have been cleared in the past 20 years.

An Inventory ecologist found a 32-acre wetland in the next county to the south, the only sizeable natural pond in this part of the state. The fieldworkers completed the survey of the area, but on a later flight they saw the wetland being drained and cleared.

A recently completed barge canal removed one-third of the forest along the lower Kaskaskia River in St. Clair County--the largest continuous block of bottomland timber in Illinois. Some of the finest upland forests in Illinois have been maintained by farmers in St. Clair County, and large stands of bottomland forest are among the very few in Illinois that probably were never logged or grazed, but the barge canal removed much of the timber. The canal promises accelerated development of the upland natural areas. When a staff member went to the county agricultural office for aerial photos of three woodlots, developers were asking for photos of the same three forests.

In Brown and Schuyler counties, fieldworkers flew from woodlot to woodlot looking for natural areas. Timber in 15 out of 42 potential areas had been harvested recently. In Madison County, 34 out of 54 potential areas had been logged. In Edwards County, a staff ecologist chose 19 forests and wetlands by examining maps and aerial photos. The aerial survey revealed that all had been cleared or disturbed by logging, clearing, or draining. The aerial survey was a discouraging exercise, but it proved that the aerial photo interpretation techniques were sound because the areas chosen for mature, well-structured forest were the same ones chosen by loggers.

Northeastern Illinois has the highest concentration of natural areas and the greatest pressure from development. An ecologist chose about 150 potential wetland natural areas in McHenry County by examining 1970 aerial photos. When he finished, 1974 aerial photos became available, so he rechecked the areas. Thirty-one of the 150 wetlands had been altered in the 4-year interval, mostly by filling for construction.

By studying series of older aerial photos, a northern Illinois fieldworker discovered prairies that had been preserved in the backs of estates north of Chicago. The prairies, dominated by northern dropseed, had a characteristic tone, texture, and pattern on the photos. Examining old aerial photos showed that these prairies extended farther south along a highway, but new aerial photos showed a golf course instead.

One of the greatest discoveries was a 60-acre tract on the Lake-Cook county line north of Chicago with mesic prairie, wet-mesic prairie, and sedge meadow. The area had been disturbed in the past, but there were 14 acres of high to very high quality prairie, with eastern massasauga rattlesnakes and hundreds of white lady's slipper orchids. One of the finest black-soil prairies in the state, it was previously unknown to naturalists. Negotiations were underway to preserve the area when the prairie sod was stripped away by a bulldozer on Labor Day weekend 1976.

Since 1971, at least 500 acres of natural prairie and marsh have been destroyed for housing at the south edge of Chicago. Some of the prairies have been destroyed so recently that they are included in this report's summaries and statistics as if they still exist.

Not all of the sites selected as potential natural areas that were recently developed would have been natural areas. Only about 12% of the areas first chosen were significant natural areas. But relatively undisturbed land of any kind is being used for other purposes faster than it could be surveyed, faster than the significant sites can be preserved.

Why Natural Areas Exist

Introduction

Natural areas exist for several reasons (Appendix 15). Some have

been deliberately protected. Many cannot be economically exploited. Some have survived despite disturbances. Many have escaped development through accidents of land use patterns. Survival of a natural area often depends on the economics and the motivation of the landowner. Some people will not develop and profit from a natural area because they do not need the money, do not care to have the money, or do not have the money needed to exploit the area. Some people cannot afford to own a natural area without making an income from it. Others use money earned elsewhere to develop a natural area (such as a wetland) that by itself would not be economical to use. A relatively large part of the areas that are protected are owned by elderly people.

The factors that have allowed tracts to remain undisturbed or to recover from disturbance are to some extent the same factors that will continue to conserve natural areas. One factor that has increased greatly in the last decade is deliberate protection of natural areas. Changes in economics and land use that work against preservation of natural areas have also increased greatly; and many areas that survived undisturbed until the 1960's and 70's would have been destroyed by now if they had not been intentionally protected.

About one-third of the natural areas are protected, at least informally. This rather high percentage may be taken either positively or negatively. It is good that so many areas are protected, but this may indicate that the chances of a natural area surviving without protection are not high.

Forests

Most undisturbed forests have been deliberately protected. A few survive because the sites are so steep or rocky that the timber has not been worth harvesting. Other factors involved in preservation of forests are listed in Table 33.

The settlers on the Illinois prairie regarded their forests as a valuable resource. As a result, a higher percentage of forest remains undisturbed in the Grand Prairie counties than in the southern counties that had no prairie. Woodlots have been protected on small farms for

generations, and a few large forested tracts were preserved by people who farmed the rich central Illinois prairie.

Many woodlots have been protected from logging but not from grazing. It is no longer worth the labor and investment for most farmers in central Illinois to keep livestock, so these woods are usually no longer grazed. However, little remains of the original natural community except for the old trees. The soil, animal life, understory, and herb layer have been so greatly changed by livestock that the original forest community cannot recover.

Timber cutters have protected forests both directly and indirectly. Owners of high quality timber are under heavy, continual pressure from timber buyers. Several landowners have not sold their timber because they feel that their enjoyment of the forest would be limited for years after the timber harvest. A few forests are protected only in the sense that the owner is waiting for a higher price before selling the timber. Some of the most outstanding forests are owned by sawmill operators who choose to spare their woods.

Expensive suburban homes have led to protection of some forests in ravines. Since the homes have been built surrounding the forests, they have been protected as neighborhood showpieces. Several large forested tracts have been acquired by park districts and forest preserve districts around large cities. Most had been disturbed but have been protected for so long that they now qualify as natural areas. Many forests are being given the protection they need to mature and recover from past disturbances in state parks.

Prairies

Most prairie remnants are on soil that is too sandy, rocky, wet, or steep to cultivate or pasture economically. The prairies that formed the deep, fertile soils are almost entirely farmed, but a few small remnants persist for the reasons listed in Table 34.

The rocky or gravelly remnants have almost all been pastured, but the dryness of the soil allows the prairie to persist. Relatively few non-native plants can survive on extremely dry sites, so the prairie persists because nothing can replace it.

The great majority of hill prairies have been grazed, but they have a relatively high survival rate. Nyboer (1978) found that 13% of the hill prairies along the lower Illinois and lower Mississippi rivers qualified as natural areas. The ones most likely to survive are small openings in the forest isolated above high cliffs. At the other extreme, the large hill prairies on loess slopes that extend down to farmsteads have been used as pastures too long to be natural.

Two prairies in western Illinois survive against seemingly impossible odds in almost identical situations. They are on deep, fertile soils on moderately sloping land along small drainageways. Such areas are almost always Kentucky bluegrass pastures or crop fields. However, each prairie is at the very south end of a rectangular property, and is separated from the rest of the property by a small intermittent stream. In both cases, the owner's access is from the north, although one prairie has a road along the south edge. Cattle grazing on the properties did not often venture across the creek, so the prairies have persisted, relatively undisturbed on land that all experience dictates would be ruined by grazing. Such prairies are so rare that the Inventory probably would not know about one of them today if a farmer had not mentioned the little rattlesnakes that kept venturing into his field, setting off a chain of conversations that led to the Illinois Nature Preserves Commission.

The chance of a natural prairie persisting in Illinois is so slight that more than one factor working in combination has often been necessary for the prairie's continued existence. For example, a prairie might be both sandy and poorly drained, or it might be too sandy to cultivate and too distant from the stock barn to graze. An extreme example is a prairie in the Fox River bottomland, which may have five reasons why it is a natural area: (1) It is naturally wet, so it was not cultivated, and stock could not graze it severely. (2) It is divided by a railroad which impedes surface runoff and contributes to the wetness. (3) The railroad right-of-way probably also served as a refuge for prairie species when the prairie was being grazed, providing a seed source for prairie plants when the grazing was stopped. (4) The tract is remote from any farmstead, so it probably was not grazed intensively. (5) About 30 years ago, a

stripmine isolated the property from a road, and it has remained idle since that time, recovering from past disturbance. In this case, a railroad and a stripmine contributed to the protection of a prairie--such circumstances are not unusual.

Many prairie remnants, especially the ones on soil that could be cultivated, are accidents of economics and land use patterns. Sixty-two prairie remnants are on railroad rights-of-way or still persist after the tracks have been removed, and 17 are in the abandoned or unused parts of cemeteries. Seven prairies are on parts of public lands that are not intensively used, such as land at a former Army arsenal, at an airport, and along the Chicago Sanitary and Ship Canal.

Some of the largest natural prairies are in the Chicago metropolitan area, on land that was subdivided in the 1920's. Lots were bought by speculators and prospective home-owners, but the economic depression of the 1930's prevented the land from being developed. In some cases sidewalks were built, but no sewer lines were laid, in part because of the sandy, wet, unstable soil. Cities grew up around the prairies, and local ordinances prevented people from building on the small lots. The largest of these tracts, at Markham, is being preserved through the efforts of many people, including the Gensburg family, who donated much of the prairie. The history and efforts to preserve another of these prairies in Cook County, along Wolf Road, was described by Hanson (1975).

The Inventory found five prairies in Illinois that were deliberately protected in private ownership. All had suffered some disturbance (usually grazing) but the Grade A and B acreage totals 32.3 acres. Four of the five prairies are now owned or are in the process of being transferred to agencies that will protect and manage them. The Illinois Central Railroad Company was given over 2.5 million acres of public land--mostly virgin prairie--in 1851 to finance construction of a railroad, and the main line of the Illinois Central was completed in 1856. The track extended the length of the state, from Cairo to Galena, with a branch from Centralia to Chicago. The railroad was built on a strip of land 200 feet wide and 705 miles long, a nearly double north-south cross-section of the state. A total of 3.2 acres of Grade A and B prairie was found along this

right-of-way, in three patches. One or two of these prairies may have been destroyed since they were last visited, which may leave one patch, 25 feet wide and 560 feet long. The only barrier separating the prairie from a crop field is a line of telegraph poles.

Savannas and barrens

Natural savanna and barren remnants persist in Illinois for the same reasons as prairies, although the savannas and barrens are fewer and consequently have fewer factors responsible for their existence (Table 35).

Savannas occurred in bands between streamside forests and upland prairies, and there were extensive savannas on rolling hills and sandy plains in northern Illinois. The general appearance of the original savannas is preserved to some degree in pastures with scattered, broad-crowned oaks, but the native grasses and forbs have been replaced by Kentucky bluegrass, which most scientists agree is not native to North America. If the savannas were not cleared for farmland or greatly changed by grazing, then they have grown into forests since the prairie fires stopped. This rapid phenomenon was recorded by observers such as Englemann (1863) and authors quoted by Curtis (1959).

The Inventory found eight natural savanna remnants on fine-textured soils. The seven dry-mesic savanna remnants are in cemeteries, and they total 10.3 acres. One natural remnant of mesic savanna was found, a 2-acre stand isolated in a wetland. In contrast, 1,232 acres of natural savanna were found on sandy soil. A relatively high percentage of sand savannas remain natural because (1) the sandy soil was not cultivated, (2) the native prairie plants could persist on droughty soil despite disturbance, (3) much of the land was grazed as open range rather than confined pastures, and (4) many of the savannas have been periodically burned.

Early writers and present-day authors have applied the term *barren*, or *barrens*, to a variety of natural communities. The Inventory reserved the term for local inclusions of prairie and savanna species mixed with trees in forest openings. Natural barren remnants are very rare in Illinois: 13 barrens were identified as natural areas, with a total of 69 acres of medium to very high quality communities. They usually occur

where the soil is so thin and dry that trees have not been able to encroach and cattle have not eliminated the native herbs.

Wetlands and ponds

Although ponds are in a community class separate from wetlands (Appendix 30), they are included with wetlands in this discussion because they often occur together and have escaped destruction for the same reasons (Table 36).

Most of the remaining wetlands have survived despite past efforts to drain them. Almost all have been altered by attempts to exploit them. In some cases, a wetland probably has survived because the owners cannot agree to drain it, or the key landowner does not want to drain it. Many wetlands are not yet worth the effort to drain or fill, and some have been protected for hunting, fishing, and trapping.

Most Category I wetlands either are (1) areas buffered by undeveloped land, (2) remnants of formerly extensive marshes or swamps that can be drained no further, or (3) small seepage areas. Small ponds and marshes fed by runoff from farmland have almost all been ruined by siltation and chemical pollution.

Primary communities

The Grade A and B primary communities are relatively undisturbed because they are glades, bluffs, and cliffs that are too rocky or steep to exploit, but there are some exceptions. For example, five of the seven limestone glade natural areas in Hardin County--the largest concentration in Illinois--are near quarries, and several others have already been removed by mining.

Caves

The two greatest disturbances to caves are vandalism and pollution of the cave's water. A cave's features and its ecosystem are easily damaged, and they recover slowly, if at all (Mohr, 1972; White, 1973). Stitt (1977) describes 57 kinds of human impacts on caves. Vandalism is in direct proportion to the amount of visitation, so most caves in recreation areas are essentially ruined. Caves have been intersected by limestone mines, but quarry operators avoid caves as much as possible. The

overall most outstanding cave in Illinois was spared from a quarry that came within 15 feet of the cave, when the quarry operators were told of the value and exact location of the cave.

Habitats with endangered plants

Nearly three-quarters of the habitats with endangered plants are on land that is too steep, dry, rocky, gravelly, sandy, or wet to develop easily (Table 37), and about 40% of the total are wet areas. About one out of eight endangered plant habitats exists because the land has been preserved. Most of the other places with endangered plants are typical, unprotected forest or disturbed, artifical sites such as ditches.

Habitats with endangered animals

Most endangered animals require prairie habitats, or large tracts of wetland or forest, or clean water. Some species, such as the eastern spadefoot toad (which breeds in ditches and burrows beneath crop fields), have adapted to human disturbance at least enough to avoid extirpation. Some animals, as well as plants, are considered endangered in Illinois only because their natural ranges barely extend into the state.

Habitats with relict species

Relict sites have survived because of unusual topographic or soil characteristics that have prevented the land from being developed. As detailed in Section 18, the relict sites are either steep bluffs and ravines, cliffs, sandy areas, or seeps.

Geologic areas

Although specific sites may be destroyed, and some unusual outcrops, landforms, and fossil beds may become endangered, in general the geologic features of Illinois are not threatened. Many of the sites chosen for the Inventory are artificial exposures.

School natural areas and nature preserves

Of the 251 areas with Category V significant features, the reasons for the protected status is as follows (with the number of areas for each reason):

Land donated to a preservation agency. 31

Land purchased, leased, or dedicated as a nature preserve or natural area 97

Land acquired by an agency (school, conservation district, etc.), not specifically for nature preservation, but subsequently designated as a natural area. 95

Land protected for an unknown reason 28

Most school natural areas and nature preserves are in northeastern Illinois, where there are the most schools and where the large numbers of people demand preservation of open space. However, there are small nature study areas maintained by local schools in many downstate counties. Such areas were the only sites listed as natural areas in three counties.

Unique natural areas

Most unique natural features are in caves, wetlands, or habitats that support endangered or relict species, so the above comments about these kinds of areas are pertinent here.

Lakes and streams

The lakes and streams listed by the Inventory were recommended by the Illinois Natural History Survey, mainly on the basis of the native fauna, which depends largely on the quality and diversity of habitats (Smith, 1971).

Most of the outstanding lakes are glacial lakes that have not been heavily affected by dredging, filling, surrounding residential development, and recreational activities. Spring Lake, on the Illinois River, probably still has a relatively good assemblage of native lake-inhabiting fishes because it is fed by large springs and is protected from the polluted waters of the Illinois River by levees.

Some of the outstanding streams have relatively small watersheds with little cropland, so they are not greatly affected by agricultural pollution. Some of the streams listed as natural areas drain large farm regions, and they probably have been able to maintain relatively natural faunas because they have a diversity of habitats, including gravel bars, riffles, and deep pools. Forbes (1928) estimated that there were 480 permanent streams in Illinois, totaling 11,912 miles, excluding the

Mississippi, Ohio, and Wabash rivers, but not many streams can be considered outstanding: 12 stream segments were listed in the inventory, totaling about 210 miles.

Future Trends

Many of the most outstanding natural areas in Illinois are already preserved. Within the next few years, many decisions will be made about whether a vulnerable natural area will be protected. If preservation actions are deferred, the area will be used for some other purpose.

Some areas have survived until recently because they have been protected by the owners. In some instances, the persons who had protected the natural areas have died, and the sites are in jeopardy.

Areas that have been safe until recently are being exploited because of changing economics. Hill prairies were once worth very little, but now they make sites for expensive blufftop homes. Limestone glades were formerly among the least vulnerable of natural communities, but some are being removed by quarries. Prairies along railroads that have not been touched since the tracks were laid 120 years ago are threatened by modern maintenance methods that involve herbicides and heavy machinery. Farmers, caught between low grain prices and high prices for land and equipment, farm land that was never previously cultivated.

Section 27.
FUTURE NEEDS

Adequacy of the Present System of Preserved Areas

A plan for expanding the nature preserves system in Illinois is beyond the scope of this report, but a summary in Table 3 shows how adequately the currently preserved areas protect Illinois' natural features. Cooperation from all kinds of landowners will be necessary to assure protection of the state's natural diversity.

One hundred and twenty-four areas in Illinois may be considered preserves that have active protection and an adequate assurance of permanence. These areas include 66 Illinois Nature Preserves, 16 Federal Research Natural Areas, nine Registered Natural Landmarks, and one U. S. Forest Service Ecological Area. Forty other tracts are considered to be preserved because the titles to the land (or easements) were acquired by the Department of Conservation, universities, or private preservation organizations specifically to preserve the areas.

Table 3 lists some of the significant natural features and shows how many are represented in at least one preserved area. Protection of half to three-quarters of the features might seem sufficient from some points of view; but to protect the diversity of Illinois' natural heritage, each feature should be in at least one protected area. Every endangered species is important, and so little is left of the original natural communities that every remnant is significant. For example, the 253 sites with natural prairie, totaling 2,352 acres, represent about one-hundredth of 1% of the prairie existing when the Prairie State was admitted to the Union.

There is much potential for further contributions by the Federal Research Natural Areas program. All Research Natural Areas in Illinois are on land managed by the Fish and Wildlife Service, and 14 of the 16 Research Natural Areas are on a single national wildlife refuge. All Research Natural Areas were considered Category V significant features, but

Table 3. Degree with which natural features are represented in preserved areas. The left column gives the number of certain important features in Illinois. The middle column gives the number (and percent) of these features that occur in dedicated Illinois Nature Preserves. The right column gives the same kind of information for all preserved areas, including Illinois Nature Preserves.

Natural feature	Entire state	Illinois Nature Preserves	All preserved areas
Occurrences of significant features			
High quality natural communities.	689	57 (8%)	86 (12%)
Habitats with endangered animals.	59	6 (10%)	12 (20%)
Habitats with endangered plants	462	151 (33%)	172 (37%)
Habitats with relict species.	45	5 (11%)	9 (20%)
Outstanding geologic features	160	2 (1%)	8 (5%)
Unique natural features	30	1 (3%)	2 (7%)
Outstanding aquatic features.	17	2 (12%)	2 (12%)
Relatively undisturbed natural communities (acres)			
Forests	13,484	1,026 (8%)	2,589 (19%)
Prairies.	2,352	637 (27%)	737 (32%)
Savannas.	1,296	147 (11%)	148 (11%)
Wetlands.	6,029	1,105 (18%)	2,366 (39%)
Lakes and ponds	1,960	68 (3%)	141 (7%)
Glades and similar communities.	602	187 (31%)	187 (31%)
Natural Divisions and Sections.	34	24 (71%)	30 (88%)
Major topographic features.	21	15 (71%)	16 (76%)
Geologic formations	143	51 (36%)	61 (43%)
Major soil associations	26	20 (77%)	22 (87%)

the Inventory identified only two other significant features in the 16 Research Natural Areas: one area with an endangered plant and one stand of Grade A forest. The existing Research Natural Areas generally are of low natural quality; aside from a 16-acre tract of timber and some bedrock outcrops, the natural communities have mostly been heavily disturbed. For example, the following three areas are Federal Research Natural Areas: a 70-acre tract of farmland that was abandoned 25 years ago; a 40-acre tract designated because it has a 10-acre, 30-year old stand of black willow adjoining an artificial lake; and a 40-acre tract that includes about 12 acres of forest with 20 acres of an artificial lake and an experimental chestnut plantation on 8 acres of former cropland. There are at least 160 significant features on 96 other tracts of Federally owned land in Illinois, and many of these tracts might qualify as Research Natural Areas. Research Natural Areas could make a valuable contribution to a nature preserves system in Illinois if they included more significant features and were well distributed throughout the state.

Updating the Inventory

Monitoring natural areas

Areas must be checked periodically for threats to their integrity. They can be monitored at several levels of exactness. Various alternatives are discussed in Appendix 31.

Aside from preserving each area and having a manager responsible for each tract, on-site inspections are one way to monitor areas. The landowner is often the best steward of a natural area, and local residents might volunteer to watch and protect some areas.

An aerial survey would be relatively quick and inexpensive. Features can be studied with a fair amount of detail, particularly if the observer is familiar with the area. An aerial survey is much quicker and more effective than a ground survey for detecting disturbances.

The least expensive and quickest survey would use Landsat satellite images, but the least amount of information could be obtained from them. Even under ideal conditions, features narrower than 600 to 800 feet are

difficult to resolve. One advantage is that vegetation clearing or construction activities appear as bright, contrasting scars on the images.

Updating the information

The likelihood that new areas will be found is discussed in Section 24. A continuing effort will need to be maintained to check leads to more natural areas. The information system is designed to accept additions, deletions, and corrections. It will need to be continually updated to be a most effective tool for preservation.

Preserving All of Our Natural Heritage

The Department of Conservation requested that the Inventory focus most of its efforts on sites with high quality terrestrial or wetland natural communities, habitats with relict species, and habitats with endangered species. Less emphasis was given to geologic features and aquatic features, and the inventory of these features was based on available information rather than relying on new searches for areas. The results should meet the immediate needs for developing a system of natural areas, but it is recommended that more emphasis be placed on protecting the kinds of ecological features that were not studied in detail. These include invertebrate animals, nonvascular plants, and aquatic ecosystems.

As a first step, we need to understand how well protection of nonvascular plants and invertebrates could be achieved in natural areas identified for other reasons. The volumes of information about invertebrates compiled by the Illinois Natural History Survey could be used as a basis for understanding the size of the task and the approaches needed to protect these animals. Similarly, the biological and water quality information compiled by agencies in the Illinois Institute of Natural Resources could be used to address the needs of protecting natural lakes and streams. Special efforts to identify and protect these important features need to be supported and encouraged.

The Inventory selected relatively small, specific sites that merit special efforts for immediate protection, but preserving these sites alone will not assure that natural diversity is protected. Large tracts of forest, wetland, and grassland need to be maintained. Many animals

rely on such large areas for feeding, breeding, and resting. These areas do not necessarily need to be removed from use by people. They can sometimes have uses such as timber production, flood control, and recreation. Not all native plants can maintain their populations indefinitely in small, isolated sanctuaries without the benefit of corridors of natural land so that plant migrations can balance local extinctions.

All aspects of our natural environment need to be protected. Unless soil erosion, air and water pollution, and transformation of wildland into farmland and urban areas are controlled, native animals and plants will become further endangered, and preserved areas will become little more than museum pieces.

Preservation of the sites identified by the Inventory is an important part of conservation of natural resources. These natural areas are the best remaining examples of our natural heritage, and they are irreplaceable refuges for an abundance and diversity of natural features. They are valuable historical resources, and they are models and sources from which other areas can be restored. Preservation of these areas will be a key to successfully maintaining a healthy and productive environment.

ILLINOIS NATURAL AREAS INVENTORY TECHNICAL REPORT

VOLUME II
INFORMATION SYSTEM

Calvin C. Corbin

Illinois Natural Areas Inventory
Urbana

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INTRODUCTION

The Illinois Natural Areas Inventory Information System is a fully operative computer system for the storage, retrieval, processing, and analysis of the inventory data.

The project contract requirements for computer system development include the following:

As much of the inventory data as possible should be computerized.

The possibility of storing inventory data on an existing computer system such as IRIS, The Nature Conservancy's system, and SELGEM must be evaluated, along with other existing computerized data retrieval systems for possible use.

The system selected or produced must be operational on the State of Illinois IBM 370-168 VS system or must be accessible through a terminal located at the Department of Conservation.

One of the main features of our project proposal was that the potential users of the information system were to be "full participants in designing and implementing a system uniquely suited to their needs." Three workshops were held, in late 1975 and early 1976, in which such potential users were consulted as to what they felt were the necessary components and requirements of the proposed system. These workshops were attended by conservationists and planners from the Illinois Department of Conservation, the Illinois Department of Transportation, Southern Illinois University, the University of Illinois, the Illinois Nature Preserves Commission, the Northeastern Illinois Planning Commission, the McLean County Regional Planning Commission, and the Greater Egypt Regional Planning and Development Commission. In addition to specifying their information needs, participants in the workshops developed the following requirements and goals for the system.

The system should be "very" easy to use.

The system should need minimal programmer support.

The system should be interactive and conversational.

The user should be able to perform "conditional" searching.

The system should be able to provide report-like output geared to the Natural Areas data and user needs.

The system should be capable of performing, at a minimum, univariant statistical analysis.

The user should be able to "prioritize" the natural area sites, based on changeable weighting of a variety of data items, thereby producing a ranked list of natural areas.

The system should allow the manipulation of textual data.

The computer hardware should be reliable, and if a time sharing system, the impact of other users should be minimal.

This report will present a review of the computer systems which were examined, will explain the decision to purchase and use a minicomputer, and will discuss the advantages and disadvantages of the completed system.

EVALUATION OF EXISTING COMPUTERIZED DATA RETRIEVAL SYSTEMS

As required by the contract, the following existing computer systems were evaluated for their potential to fill the desired capabilities of the Illinois Natural Areas Inventory Information System.

IRIS

The IRIS system was created by the Center for Advanced Computation of the University of Illinois at Urbana-Champaign. IRIS is a geographic information retrieval system which resides on a Burroughs B6700 computer and is written in ALGOL. It can be run in either interactive or batch mode, but is most commonly used interactively. IRIS has a conversational command language. Data is stored and accessed by a geographic unit (a quarter section, or a quarter-quarter section) called a tract. Various classes of data may be stored in each tract. The values of the attributes of each data class are encoded before storing in the database in order to optimize storage space. IRIS was envisioned as comprising a statewide database. It is currently being used by the Northeastern Illinois Planning Commission in Chicago. Their database, of a six-county area at the quarter-section level, consists of nearly 16,000 tracts.

IRIS effeciently handles numeric data values and coded data values, but does not provide for textual data as the value of an attribute.

In IRIS, the concept of a region was developed and implemented. A region is essentially a list of tracts which satisfy some user-specified condition. Once created, the region may subsequently be accessed by name.

The IRIS command language allows the user to tabulate data by tracts, aggregate data upon a tract, and aggregate data over a region.

Output may be generated to a terminal, to a file, or to a line printer.

MONICA

The MONICA system was created by the Center for Advanced Computation at the University of Illinois at Urbana-Champaign. MONICA is an interactive statistical system which runs on a Burroughs B6700 computer. The MONICA system is written in ALGOL. MONICA may be operated in either interactive or batch mode, but nearly all use is interactive.

MONICA editor commands allow the on-line creation and editing of alpha files, numerical vectors, and numerical matrices. Commands exist for documenting vectors and files, and for performing normal library maintenance. On-line help describing MONICA commands and their use is available through the use of a help file.

MONICA allows the user to retrieve data from a set of vectors based on numerical or alpha conditions. It has standard statistical routines such as rank, regression, histogram, t-test, etc. Alpha files have a limit of six characters per entry.

MONICA has its own programming language for the user, called MONGO. With MONGO, the user can perform data manipulation not available through normal MONICA routines.

MONICA is currently being supported and used by the Northeastern Illinois Planning Commission in Chicago, the Mayor's Office of Manpower in Chicago, and the Commission on Intergovernmental Cooperation in Springfield.

Output may be generated to the terminal, to a file, or to a line printer.

SELGEM

The SELGEM system was created by the Smithsonian Institution's Information Systems Division as a joint venture with the National Museum of Natural History. SELGEM is a general purpose information management system running on a Honeywell 2015 at the Smithsonian. It consists of about 25 programs written in COBOL. Approximately 100 users at 39

other institutions use SELGEM, on a variety of hardware: IBM 360, CDC 3100, CDC 6400, UNIVAC 1110, GE 635, as well as Burroughs and ICL computers.

Although still under development, SELGEM is being used for information processing in the museum community.

SELGEM is run in batch mode only. The system requires that the user define data on a Master File layout, based on a data card image. The formatted data is then transferred to tape or disk, where it is accessible to SELGEM. The data layout consists of 80 column card images, with the first 15 columns and the last column (80) reserved for record and category identifications. Thus, information may be entered in columns 16-79. A data record may contain up to 6,237 characters. A record will generally consist of various data categories designed to allow the user to access the data. The system requires a data manager and code book.

The retrieval of data through SELGEM involves filling out a query formulation worksheet with instructions to test for a given data word in a particular category, thus turning on an indicator, and to consider indicators in conjunction with each other. Records for action requested may be printed, counted (tallied), or modified as to content. SELGEM does provide for textual searching of words, but not of phrases or expressions. There is no report generation or formatted output.

Output may be directed to tape or printer.

Natural Area Information System (NAIS)

The Nature Conservancy of Arlington, Virginia, produced this system consisting of a combination of manually accessible and computerized data. NAIS is a subsystem of an ongoing natural area management program--the State Natural Heritage Program. NAIS software requires an IBM OS-360-65 with a PL-1(F) and a Fortran IV compiler.

NAIS provides for three types of data: boolean values (or yes/no data), unstructured textual data, and graphic coordinates. The system

requires that the data attributes be specific NAIS data attributes; it is not a general information system. NAIS provides a system for encoding standardized descriptions of natural areas, storing these descriptions, and producing printouts of data as well as plotted maps of the area's location.

NAIS operates in batch mode only. It is built around a single fixed length file structure of 15,603 characters. Within the file, logical records--natural area sites--may contain up to 44 categories of information. The specification of the data items in the file system is rigid and requires that a user have only the data items which are expected.

Output is generated to a line printer or plotting device.

Consistent System/JANUS

The Consistent System (CS) was created by the Cambridge Project at Cambridge, Massachusetts. CS operates on a Honeywell 6180 and is written in PL-1. It is an extremely large environment which allows a massive number of statistically oriented routines and utilities to be invoked. JANUS is a subsystem of CS and serves primarily as a data manager.

A way of using these systems is to input data into JANUS defining data relationships between data classes and between data attributes, thus providing for hierarchical processing and retrieval. When complex numerical analysis is required, one would extract from JANUS the necessary data, move it "up" to CS, perform the analysis, and store the resultant data back in JANUS, thereby creating a new attribute of some dataset.

CS/JANUS may be used in interactive or batch (background) mode.

CS deals with numerical data. JANUS, besides dealing with numerical data, allows a restrictive number of alpha characters for data attribute values, much like MONICA.

CS/JANUS is a very large, complex system, requiring a great deal of user exactitude. A user must read a number of volumes of documentation before using the systems well. At the CS level, the user is encouraged to programmatically provide for anything which is not there by using a set of subroutines described in a two volume programmer's handbook. CS was not designed for the beginning computer user.

Because of the large environment which CS provides, it is expensive to use.

Output from CS/JANUS may be directed to a terminal, to a file, or to a line printer.

State of Illinois (TSO/Office of Management Information and Communication)

The possibility of using the existing computing facilities of the State of Illinois at Springfield was examined: specifically, whether or not TSO (time sharing option) would efficiently support the kind of interactive computing desired by the user community. An operational cost projection of this possibility is presented later.

Minicomputer

The possibility of purchasing a minicomputer was also evaluated. The final decision to purchase a minicomputer is discussed below.

SYSTEMS COMPARISON

Three systems were analyzed in detail for cost and other considerations. Of the systems used for similar purposes elsewhere, MONICA was selected for comparison because it was deemed the least expensive to operate and the easiest to use for the needs of the Inventory. The creation of a system using the State computing facilities in Springfield was considered because nearly all computing services at state level are currently provided through the Office of Management Information and

Communication (OMIC). A minicomputer was considered because it was deemed to have several characteristics, or advantages, not shared with existing systems and facilities.

Each cost analysis assumed the existence of an appropriate data management system operating on the computer. User connect hours (time logged in) were estimated at 20 hours per month. Each configuration requires a terminal: in the case of OMIC and MONICA this is to allow editing and hard copy output; and in the case of the minicomputer this is to allow hard copy output.

State of Illinois (TSO/OMIC)

Processing costs were assumed to be $15/hour based on a benchmark relating to program development (processing costs would be expected to be higher during normal program usage), remote line costs of $90/month, disk/tape storage of $50/month, system maintenance of $600/month, a terminal with editor/recorder capabilities at $3,915 on a three year purchase, and a $50/month maintenance contract on the terminal. These figures provide a projection of $14,280/year. If projected over a five year span, the cost of using OMIC would be $71,400.

MONICA

Costs were assumed to be all computer usage at $7.50/hour, remote line of $100/month, system maintenance of $200/month, a terminal with editor/recorder capabilities at $3,915 on a three year purchase, and a $50/month maintenance contract on the terminal. These figures provide a project of $7,200/year. If projected over a five year span, the cost of using MONICA would be $36,000.

Minicomputer

Cost limitations restricted consideration of a minicomputer to systems using diskettes, rather than fixed disks with their larger

capacity but higher cost. Investigation showed the most attractive and appropriate system available to be that manufactured by Wang Laboratories, of Boston, Massachusetts.

The cost of purchasing a WANG 2200T CPU with three diskette drives, a drive controller, and an upper/lower case CRT, over a three year lease/purchase arrangement, was $20,000. A GENCOM 300Q terminal for hard copy output costs $3,515. With maintenance on the WANG and the terminal at $200/month, one can project a five year cost of $34,515. Costs incurred following the hardware purchase (year three) amount only to cost of the maintenance contract, approximately $2,400/year.

Comparison

Software costs--designing, programming, and debugging--were considered to be relatively fixed, regardless of machine selection. This assumption is not totally valid, since in the case of MONICA, much usable software exists; however, in all cases, a great deal of programming would have to be performed to create a system in accord with the objectives stated earlier. An attractive consideration, from a programmer's viewpoint, regarding a minicomputer is that it becomes a single user "hands on" operation and there is no interference from other users.

Hardware and software considerations as they apply to TSO/OMIC, MONICA, and the WANG may be summarized as follows:

> TSO/OMIC--the cost of using this system would be more than twice the cost of using the WANG over a five year period. Every year after the fifth year, costs would be even more in favor of the WANG ($14,280 to $2,400). This system was considered too expensive. Besides the higher operational cost of using the system, one can not really provide a good interactive program on this operating system: an excessive core requirement is necessary to run interactively.

> MONICA--the cost of using MONICA compared to using the WANG would be about equal after five years. However, following that time period, the WANG system would save about $5,000/year. As mentioned earlier, some MONICA software could be used or adapted to the Natural Areas system; however, a great deal of new programming would be required. The machine cost of the

development of the new software would not be inconsequential. The computer on which MONICA resides supports interactive usage very well. The primary reason for deciding not to use MONICA as a framework for the natural areas system (besides the extra operational cost) was the real user benefits that could be shown by using the minicomputer and which would not be possible by using either MONICA or the TSO/OMIC system.

Some of the more important benefits of using the minicomputer include:

A computing system solely contained in the user's office should tend to promote use of the system beyond simply responding to a problem or a request for data. In a multi-user time-sharing environment, one often tends to use the system only as necessary to provide required data. In contrast, it was felt that with the system immediately available in the office the user would be encouraged to experiment with the system and data, thus doing much more real computing, and expanding the use and effectiveness of the entire project.

The user has sole control of the operation of the system: one is not dependent on someone else's schedule of operation, or someone else's security provisions.

Owning the hardware means that the user does not have to worry that the system will be replaced by another, causing reprogramming, or that it would disappear entirely, not to be replaced.

The decision to purchase a WANG minicomputer and to program a system for handling the Illinois Natural Areas Inventory data was based, then, upon four considerations: cost, possibility of tailoring a new system to the particular data and the user requirements of the Inventory, independence granted to the user who has the computer residing in his or her office, and, finally, the likelihood that an "in-house" computing environment, by encouraging use and experimentation, would increase the usefulness of the Inventory.

STRUCTURE OF THE INFORMATION SYSTEM

The programs, produced on the WANG computer system, which comprise the Illinois Natural Areas Inventory Information System may be thought of as consisting of four logical modules: data entry, table generation,

data retrieval, and text editing.

The data entry module is contained on one diskette. The programs are used to build the raw database, to enter data into the database with as much error checking as possible, and to allow editing of data which has been previously inserted in the database. Each diskette may hold up to 262,144 bytes of information--the diskettes contain 1,024 addressable 256-byte sectors. The natural areas raw database consists of 1,089 natural areas on six diskettes (room for 200 areas on each diskette). Data for each natural area entered into the raw database is stored in a combination of fixed/variable storage. Four sectors are allocated for each natural area. Should the data for the specific natural area exceed this fixed bound, overflow sectors are available for storage on the same diskette. The data is stored within the fixed four sector block in a continuous stream format. There is no data compression or encoding at this stage.

Following the creation of the entire raw database a program is run which builds a "refined" database from the raw database. This program accepts as input the raw database, one diskette at a time, and produces as output a refined database which fits on two diskettes. One of these diskettes contains all Category I natural areas; the other diskette contains data for all Category II through Category VII natural areas. The program which builds the refined database does more than condense the raw database from six diskettes to two diskettes. It creates new data element values from existing data for the natural area and associates these values with the natural area. The program also "restructures" the data into a hierarchical storage scheme. A hierarchical storage scheme is necessary to allow for conditional comparisons of data which belong to the same structure. For example, if one wanted to compare rarity index values, it would be desirable that one should have the option of deciding whether the natural community code should be taken into account; since the rarity index is essentially a further description of the particular natural community. Each natural area may define more than one natural community; thus, it is necessary that those data elements which describe one natural community be differentiated from

those which describe a different natural community within the same natural area.

The prioritization database is created programmatically from a select number of numeric data elements in the refined database. The program which accesses the prioritization database permits the user to rank natural areas, based upon a summation of the specific data elements for each natural area after a modification by a user-provided weight. The final sum is used to determine the comparative ranking of the natural areas examined. This database is created on a separate diskette.

The table generation module of the information system is a series of programs which create symbol tables for decoding values, specifying data storage, and defining range and type of the data. The tables created are used by nearly all of the programs involved in data entry and data retrieval throughout the system. These programs reside on their own diskette; the tables which are produced are stored in various locations to facilitate execution of the retrieval programs.

The data retrieval module consists of programs on one diskette which access the refined database, the preservation database, and the prioritization database. These programs are written so that the user may invoke them from a "command" level called RETRIEVE. The programs provide for conditional searching of the data, displaying any portion of the data desired, prioritization of the data, and univariant statistics. An IRIS-like concept of regions was implemented, allowing the user to define a set of natural areas which have something in common as being one logical entity for purposes of further work. These regions only exist during the specific user session and need to be created again during a different session.

The text editing (document production) module consists of a WANG software package. This package includes a normal set of editing routines. It performs library maintenance on files; thus, the user may create, name and remove files. Along with the hard copy printer, the text editing module will allow document production.

CONCLUSION

The information system fulfills all the goals listed earlier: it is easy to use, it will require minimal programmer support, it is interactive and conversational, it provides report-like output geared to the natural areas data, it provides a statistical module, it allows the user to prioritize the natural areas, it has a text editing package, and the hardware is reliable.

Based upon our experience during the project, we feel that while the system functions well, improvements could be made in two areas. The first is speed of processing. While this was considered only a minor factor when alternative systems were being considered, the slowness of the system in processing is such that it could conceivably discourage the constant hands-on experimentation which was considered a prime attraction of the in-house minicomputer. This improvement could be easily made by replacing the existing Central Processing Unit with a newer model, not available when the system was specified, at a cost of \$2,000-\$3,000. Brief use of the newer CPU during project development revealed speeds eight to twenty times faster than those using the existing unit. We have recommended that the faster CPU be placed into the system. The second area for possible improvement is storage capacity. In the evaluation phase, it was not believed that the selection of a diskette-oriented minicomputer would seriously affect normal database storage and access routines. We found, however, that our large database(s) required a large amount of time to be spent in programming our way around the storage restrictions. The minicomputer is available in fixed disk form as an alternative to diskettes, but that configuration, considerably more expensive, was ruled out by the project budget.

The existing system should be an extremely useful tool to the natural areas personnel by providing information and supporting future planning.

PART VI
REFERENCES CITED

References cited in this report are given on the following pages, except citations for the natural community classification, which are at the end of Appendix 30.

Plate 8. *Prairie plants surrounding a gravestone. One of the last remnants of the Grand Prairie of central Illinois is protected in this pioneer cemetery.*

REFERENCES CITED

Adams, C. C. 1915. An ecological study of prairie and forest invertebrates. Bulletin of the Illinois State Laboratory of Natural History 11:33-280.

Adamus, P. R. and G. C. Clough. 1976. A preliminary listing of noteworthy natural features in Maine. Center for Natural Areas, South Gardiner, Maine. 397 p.

Anderson, R. C. and M. R. Anderson. 1975. The presettlement vegetation of Williamson County, Illinois. Castanea 40:345-363.

Andrews, E. 1860. A trip in southern Illinois. Prairie Farmer 22:51.

Angle, P. M. and J. R. Getz, eds. 1957. A visit to Chicago in Indian days: Journal of the "Far-off West." [Edited manuscript of Colbee C. Benton's journal, 1833.] Caxton Club, Chicago. 121 p.

Avery, T. E. 1967. Forest measurements. McGraw-Hill Book Co., New York. 290 p.

Avery, T. E. 1968. Interpretation of aerial photographs (second edition). Burgess Publishing Co., Minneapolis. 324 p.

Avery, T. E. 1969. Forester's guide to aerial photo interpretation. U. S. Department of Agriculture Handbook 308. 40 p.

Baker, S. and H. W. Dill, Jr. 1970. The look of our land--An airphoto atlas of the rural United States: The East and South. U. S. Department of Agriculture Handbook 406. 99 p.

Baker, S. and H. W. Dill, Jr. 1972. The look of our land--An airphoto atlas of the rural United States: North Central. U. S. Department of Agriculture Handbook 384. 64 p.

Bell, D. T. and W. M. Zales. [1977.] Vascular plants of Will County: Annotated checklist, ecological summary, and natural area inventory. Report sponsored in part by Illinois Division of Water Resources and Will County Forest Preserve District. 76 p.

Bennett, S. 1977. The virgin forest--How can you tell? Yankee, December 1977:102-107.

Betz, R. F. 1972. The use of old and abandoned cemeteries as prairie preserves (Abstract). P. 21 *in* J. H. Zimmerman, ed. Proceedings of the Second Midwest Prairie Conference. University of Wisconsin, Madison.

Betz, R. F. 1976. Tracking the prairie. Prairie Farmer 148(21):56-57.

Betz, R. F. 1978. The prairies of Indiana. P. 25-31 *in* D. C. Glenn-Lewin and R. Q. Landers, Jr., eds. Fifth Midwest Prairie Conference proceedings. Iowa State University, Ames.

Betz, R. F. and H. F. Lamp. 1973. The species composition of old settler cemetery prairies in northern Illinois and northwestern Indiana (Abstract). P. 47 *in* L. C. Hulbert, ed. Third Midwest Prairie Conference proceedings. Kansas State University, Manhattan.

Betz, R. F. and H. F. Lamp. 1978. The flower, pod, and seed production in eighteen species of Midwestern milkweeds. P. 12 *in* Abstracts of contributed papers for the Sixth North American Prairie Conference. Ohio State University, Columbus.

Beveridge, T. R., F. C. Wahley, and L. E. Lambelet. 1957. Topographic maps of Missouri. Missouri Geological Survey and Water Resources Information Circular 15. 27 p.

Bohlen, H. D. 1978. An annotated check-list of the birds of Illinois. Illinois State Museum Popular Science Series, Volume 9. 156 p.

Bowles, M. L., K. Kerr, R. H. Thom, and D. E. Birkenholz. 1978. Threatened, endangered, and extirpated birds of Illinois prairies. P. 14 *in* Abstracts of contributed papers for the Sixth North American Prairie Conference. Ohio State University, Columbus.

Bretz, J H. and S. E. Harris, Jr. 1961. Caves of Illinois. Illinois State Geological Survey Report of Investigations 215. 87 p.

Buckman, R. E. and R. L. Quintus. 1972. Natural areas of the Society of American Foresters. Society of American Foresters, Washington, D. C. 38 p.

Burde, J. H., III and D. C. Baumgartner. 1978. Availability of forest and associated land resources in Illinois. U. S. Forest Service Research Note NC-236. 4 p.

Chapman, K. A. and R. J. Pleznac. 1978. A survey of prairie preservation and prairie reconstruction in Michigan. P. 19 *in* Abstracts of contributed papers for the Sixth North American Prairie Conference. Ohio State University, Columbus.

Cory, C. B. 1912. The mammals of Illinois and Wisconsin. Field Museum of Natural History Publication 153. Zoological Series, Volume 6. 505 p.

Cote, W. E. 1967. Guide to the use of Illinois topographic maps. Illinois State Geological Survey, Urbana. 21 p.

Curtis, J. T. 1959. The vegetation of Wisconsin. University of Wisconsin Press, Madison. 657 p.

Curtis, J. T. and H. C. Greene. 1949. A study of relic Wisconsin prairies by the species-presence method. Ecology 30:83-92.

Day, R. K. and D. DenUyl. 1932. The natural regeneration of farm woods following the exclusion of livestock. Purdue University Agricultural Experiment Station Bulletin 368. 48 p.

DeBruin, R. 1970. 100 topographic maps illustrating physiographic features. Hubbard Press, Northbrook, Illinois. 128 p.

DenUyl, D., O. D. Diller, and R. K. Day. 1938. The development of natural reproduction in previously grazed farmwoods. Purdue University Agricultural Experiment Station Bulletin 431. 28 p.

Dickson, P. 1977. Out of this world: American space photography. Dell Publishing Co., New York. 158 p.

Douglas, C. L., Jr., J. B. Fehrenbacher, and B. W. Ray. 1967. The lower boundary of selected mollisols. Soil Science Society of America Proceedings 31:795-800.

Drury, W. 1974. Rare species. Biological Conservation 6:162-169.

Dyrness, C. T., J. F. Franklin, C. Maser, S. A. Cook, J. D. Hall, and G. Faxon. 1975. Research Natural Area needs in the Pacific Northwest: A contribution to land-use planning. U. S. Forest Service General Technical Report PNW-38. 231 p.

Engelmann, H. 1863. Remarks upon the causes producing the different characters of vegetation known as prairies, flats, and barrens in southern Illinois, with special reference to observations made in Perry and Jackson counties. American Journal of Science and Arts 86:384-396.

Evers, R. A. 1955. Hill prairies of Illinois. Illinois Natural History Survey Bulletin 26:367-446.

Evers, R. A. 1963. Some unusual natural areas in Illinois and a few of their plants. Illinois Natural History Survey Biological Notes No. 50. 32 p.

Evers, R. A. and L. M. Page. 1977. Some unusual natural areas in Illinois. Illinois Natural History Survey Biological Notes No. 100. 47 p.

Federal Committee on Ecological Reserves. 1977. A directory of Research Natural Areas on Federal lands of the United States of America. U. S. Forest Service, Washington, D. C. 280 p.

Fehrenbacher, J. B., G. O. Walker, and H. L. Wascher. 1967. Soils of Illinois. Illinois Agricultural Experiment Station Bulletin 725. 47 p. + map.

Fell, G. B., M. Hutchison, G. Paulson, J. E. Schwegman, W. M. Shepherd, and J. White. 1972. Comprehensive plan for the Illinois Nature Preserves System, Part 1--Guidelines. Illinois Nature Preserves Commission, Rockford. 13 p.

Fenneman, N. M. 1928. Physiographic divisions of the United States. Annals of the Association of American Geographers 18:261-353.

Fentress, C. D. and R. G. Frye. 1975. Wildlife management by habitat units--A preliminary plan of action. P. 245-262 *in* Proceedings of the NASA Earth Resources Survey Symposium, Houston, Texas, June 1975. NASA TM X-58168.

Forbes, S. A. 1928. The biological survey of a river system--Its objects, methods, and results. Bulletin of the Illinois State Natural History Survey 17:277-284.

Gates, P. W. 1934. The Illinois Central Railroad and its colonization work. Harvard University Press, Cambridge. 374 p.

Gehlbach, F. R. 1975. Investigation, evaluation, and priority ranking of natural areas. Biological Conservation 8:79-88.

George F. Cram Company. 1909. Railroad map of Illinois. Chicago. 1:506,880 scale map.

Goodnight, C. J. and E. J. Koestner. 1942. Winter home ranges of some small Illinois mammals. Journal of the Tennessee Academy of Sciences 17:276-279.

Goodwin, R. H. and W. A. Niering. 1975. Inland wetlands of the United States evaluated as potential Registered Natural Landmarks. National Park Service Natural History Theme Studies Number Two. U. S. Government Printing Office, Washington, D. C. 550 p.

Gould, F. W. 1941. Plant indicators of original Wisconsin prairies. Ecology 22:427-429.

Graber, J. W., R. R. Graber, and E. L. Kirk. 1978. Illinois birds: Ciconiiformes. Illinois Natural History Survey Biological Notes No. 109. 80 p.

Graber, R. R. and J. W. Graber. 1963. A comparative study of bird populations in Illinois, 1906-1909 and 1956-1958. Illinois Natural History Survey Bulletin 28:383-528.

Gunning, G. E. 1963. Illinois. P. 163-189 *in* D. G. Frey. Limnology in North America. University of Wisconsin Press, Madison.

Hankinson, T. L. 1915. The vertebrate life of certain prairie and forest regions near Charleston, Illinois. Bulletin of the Illinois State Laboratory of Natural History 11:281-303.

Hankinson, T. L. 1917. Amphibians and reptiles of the Charleston region. Transactions of the Illinois State Academy of Science 10: 322-330.

Hanson, P. 1975. Wolf Road Prairie. Field Museum of Natural History Bulletin 46(2):3-7.

Henderson, H. 1977. The Illinois: World's most-studied river. Illinois Times, November 18-24:5-9.

Hoffmeister, D. F. and L. G. Grebner. 1948. A specimen of the white-tailed jack rabbit, *Lepus townsendii*, from Illinois. Chicago Academy of Sciences Natural History Mescellanea 29. 2 p.

Hoffmeister, D. F. and C. O. Mohr. 1957. Fieldbook of Illinois mammals. Illinois Natural History Survey Manual 4. 233 p.

Hovind, H. J. and C. E. Rieck. 1970. Basal area and point-sampling: Interpretation and application. Wisconsin Department of Natural Resources Technical Bulletin 23 (revised edition). 52 p.

Humke, J. W., B. S. Tindall, R. E. Jenkins, H. L. Wieting, Jr., and M. S. Lukowski. 1975. The preservation of natural diversity: A survey and recommendations. Report by The Nature Conservancy for the U. S. Department of the Interior, Washington, D. C. 212 p. + appendices.

Illinois Board of Higher Education. 1975. A work force for environment and energy: A master plan for environmental/energy higher education in Illinois. [Springfield.] 418 p.

Illinois Central Rail-Road Company. 1856. The Illinois Central Rail-Road Company offers for sale over 2,000,000 acres selected farming and wood lands, in tracts of forty acres and upwards, to suit purchasers, on long credits and low rates of interest, situated on each side of their rail-road, extending all the way from the extreme north to the south of the state of Illinois. John W. Amerman, New York. 64 p. + map.

Illinois Conservation Needs Committee. 1970. Illinois soil and water conservation needs inventory. University of Illinois Cooperative Extension Service, Urbana. 192 p.

Illinois Department of Conservation. 1972. Natural area evaluation sheet for determining priority of land acquisition projects. Springfield. Form + 2 p. text.

Illinois Department of Conservation. 1978. Nature preserves are busy laboratories. Outdoor Highlights 6(6):12. [Illinois Department of Conservation, Springfield.]

Illinois Environmental Protection Agency. 1978. A land cover inventory from space: Staff report. Springfield. 73 p. + appendices.

Illinois Nature Preserves Commission. 1969. Natural area acquisition project evaluation. Rockford. Form + 3 p. text.

Illinois Nature Preserves Commission. 1973. Illinois Nature Preserves two-year report, 1971-1972. Rockford. 65 p.

Illinois Nature Preserves Commission. 1977. Preserving Illinois' natural heritage: Biennial report, 1975-1976. Rockford. 56 p.

Isfort, L. G. 1949. A partial bibliography of natural history in the Chicago region. American Midland Naturalist 42:406-472.

Jenkins, R. 1977. Selection of natural areas in Heritage Programs. P. 55-56 *in* Ohio Natural Heritage Program technical report. Ohio Department of Natural Resources, Columbus.

Jenkins, R. E. 1978. Heritage classification: The elements of our natural diversity. The Nature Conservancy News 28(1):24-25, 30.

Jones, J. K., Jr., D. C. Carter, and H. H. Genoways. 1975. Revised checklist of North American mammals north of Mexico. Occasional Papers of the Museum, Texas Tech University 28. 14 p.

Keller, G. T. 1978. Restoring native prairie vegetation. Soil Conservation 43(7):20.

Kennicott, R. 1855. Catalogue of animals observed in Cook County, Illinois. Transactions of the Illinois State Agricultural Society 1: 577-595.

Kennicott, R. 1857. The quadrupeds of Illinois, injurious and beneficial to the farmer. Transactions of the Illinois State Agricultural Society 2:615-684.

King, C. C. 1978. A right-of-way prairie near Milford Center, Union County, Ohio. P. 22 *in* Abstracts of contributed papers for the Sixth North American Prairie Conference. Ohio State University, Columbus.

King, C. C. and L. E. Elfner, eds. 1975. Organisms and biological communities as indicators of environmental quality--A symposium. Ohio Biological Survey Informative Circular No. 8. 65 p.

King, D. B. and R. K. Winters. 1952. Forest resources and industries of Illinois. University of Illinois Agricultural Experiment Station Bulletin 562. 95 p.

Klimstra, W. D. 1969. Mammals of the Pine Hills--Wolf Lake--LaRue Swamp complex. Chicago Academy of Sciences Natural History Miscellanea 188. 10 p.

Koestner, E. J. 1941. Some recent records of central Illinois mammals. Journal of the Tennessee Academy of Sciences 16:46-47.

Kohring, M. 1978. Saving Michigan's railroad strip prairies. P. 10 *in* Abstracts of contributed papers for the Sixth North American Prairie Conference. Ohio State University, Columbus.

Krohe, J., Jr. 1978. An 1843 guidebook to Illinois. Illinois Times, November 17-23:20-23.

Larimore, R. W. and P. W. Smith. 1963. The fishes of Champaign County, Illinois, as affected by 60 years of stream changes. Illinois Natural History Survey Bulletin 28:299-382.

Leighton, M. M., G. E. Ekblaw, and C. L. Horberg. 1948. Physiographic divisions of Illinois. Journal of Geology 56:16-33.

Lindsey, A. A. 1962. Analysis of an original forest of the lower Wabash floodplain and upland. Proceedings of the Indiana Academy of Science 72:282-287.

Lindsey, A. A., J. D. Barton, Jr., and S. R. Miles. 1958. Field efficiences of forest sampling methods. Ecology 39:428-444.

Lineback, J. A. 1975. Illinois geology from space. Illinois State Geological Survey Environmental Geology Notes No. 73. 36 p.

Long, C. A. 1968. Populations of small mammals on right-of-way in prairie of central Illinois. Transactions of the Illinois State Academy of Science 61:139-145.

Lord, R. D., Jr. 1959. A method for measuring mortality of cottontail rabbits in winter. Journal of Wildlife Management 23:241-243.

McManis, D. R. 1964. The initial evaluation and utilization of the Illinois prairie, 1815-1840. University of Chicago, Department of Geography Research Paper 94. 109 p.

Madany, M. 1977. Looking for 'unimproved' land: The Illinois Natural Areas Inventory. Field Museum of Natural History Bulletin 48(6):18-23.

Malkovich, D. 1962. Spectacular formations abound in Illinois' seldom-visited Lost Stream. Outdoor Illinois 1(5):4-10.

Miller, L. W. 1943. The use of prairie relics in teaching. Transactions of the Illinois State Academy of Science 36:102.

Mills, H. B., W. C. Starrett, and F. C. Bellrose. 1966. Man's effect on the fish and wildlife habitat of the Illinois River. Illinois Natural History Survey Biological Notes No. 57. 24 p.

Mohlenbrock, R. H. 1971. Little Grand Canyon. Outdoor Illinois 10(6): 19-26.

Mohlenbrock, R. H. 1975. Guide to the vascular flora of Illinois. Southern Illinois University Press, Carbondale. 494 p.

Mohr, C. E. 1972. The status of threatened species of cave-dwelling bats. Bulletin of the National Speleological Society 34:33-47.

Nixon, C. M., S. P. Havera, and R. E. Greenberg. 1978. Distribution and abundance of the gray squirrel in Illinois. Illinois Natural History Survey Biological Notes No. 105. 55 p.

Nyboer, R. W. 1978. The decline of Illinois hill prairies due to grazing. P. 15 *in* Abstracts of contributed papers for the Sixth North American Prairie Conference. Ohio State University, Columbus.

Ohmann, L. F. 1973. Vegetation data collection in temperate forest research natural areas. U. S. Forest Service Research Paper NC-92. 35 p.

Park, O., S. Auerbach, and M. Wilson. 1953. Pselaphid beetles of an Illinois prairie: The population. Ecological Monographs 23:1-16.

Peck, S. B. and J. J. Lewis. 1978. Zoogeography and evolution of the subterranean invertebrate faunas of Illinois and southeastern Missouri. NSS [National Speleological Society] Bulletin 40:39-63.

Pemble, R. H., R. L. Stuckey, and L. E. Elfner. 1975. Native grassland ecosystems east of the Rocky Mountains in North America: A preliminary bibliography. A supplement to Prairie: A multiple view, edited by M. K. Wali. University of North Dakota Press, Grand Forks. 466 p.

Pepoon, H. S. 1915. Peculiar examples of plant distribution: A problem in phyto-geography (Abstract). Transactions of the Illinois State Academy of Science 8:136.

Pepoon, H. S. 1916. Peculiar plant distributions. Transactions of the Illinois State Academy of Science 9:128-137.

Pepoon, H. S. 1927*a*. An annotated flora of the Chicago region. Chicago Academy of Sciences Natural History Bulletin 8. 554 p.

Pepoon, H. S. 1927*b*. The flora of the right of way of the Illinois Central Railway: Waddams to East Dubuque. Transactions of the Illinois State Academy of Science 20:92-98.

Pepoon, H. S. 1928. Vegetation along the Illinois Central Railroad. Transactions of the Illinois State Academy of Science 20:72-79.

Poggi, E. M. 1934. The prairie province of Illinois: A study in human adjustment to the natural environment. University of Illinois Studies in the Social Sciences 19(3):1-124.

Ramey, R. E. 1978. A right-of-way prairie near Zimmerman, Greene County, Ohio. P. 36 *in* Abstracts of contributed papers for the Sixth North American Prairie Conference. Ohio State University, Columbus.

Rapp, J. L. C. 1946. List of Myriapoda taken in Champaign County, Illinois during the fall and winter of 1944-1945. American Midland Naturalist 36:666-667.

Ratcliffe, D., ed. 1977. A nature conservation review. Volume 1. Cambridge University Press, London. 320 p.

Ray, R. G. 1960. Aerial photographs in geologic interpretation and mapping. U. S. Geological Survey Professional Paper 373. 230 p.

Richardson, R. E. 1921*a*. The small bottom and shore fauna of the middle and lower Illinois River and its connecting lakes, Chillicothe to Grafton: Its valuation; its sources of food supply; and its relation to the fishery. Bulletin of the Illinois State Natural History Survey 13:363-522.

Richardson, R. E. 1921*b*. Changes in the bottom and shore fauna of the middle Illinois River and its connecting lakes since 1913-1915 as a result of the increase, southward, of sewage pollution. Bulletin of the Illinois State Natural History Survey 14:33-75.

Richardson, R. E. 1925*a*. Changes in the small bottom fauna of Peoria Lake, 1920 to 1922. Bulletin of the Illinois State Natural History Survey 15:327-388.

Richardson, R. E. 1925*b*. Illinois River bottom fauna in 1923. Bulletin of the Illinois State Natural History Survey 15:391-422.

Richardson, R. E. 1928. The bottom fauna of the middle Illinois River, 1913-1925: Its distribution, abundance, variation, valuation, and index value in the study of stream pollution. Bulletin of the Illinois State Natural History Survey 17:387-475.

Richason, B. F. 1972. Atlas of cultural features. Hubbard Press, Northbrook, Illinois. 96 p.

Ridgway, R. 1872*a*. Notes on the vegetation of the lower Wabash valley. I. The forests of the bottomlands. American Naturalist 6:658-665.

Ridgway, R. 1872*b*. Notes on the vegetation of the lower Wabash valley. II. Peculiar features of the bottomlands. American Naturalist 6: 724-732.

Ridgway, R. 1882. Notes on the native trees of the lower Wabash and White river valleys in Illinois and Indiana. Proceedings of the United States National Museum 5:49-88.

Ridgway, R. 1894. Additional notes on the native trees of the lower Wabash valley. Proceedings of the United States National Museum 17:409-421.

Sabins, F. F., Jr. 1978. Remote sensing: Principles and interpretation. W. H. Freeman and Co., San Francisco. 426 p.

Sargent, F. O. and J. H. Brande. 1975. Natural area classification. University of Vermont Agricultural Experiment Station Research Report 87. 14 p.

Sargent, F. O. and J. H. Brande. 1976. Classifying and evaluating unique natural areas for planning purposes. Journal of Soil and Water Conservation 31:113-116.

Schanzle, R. W. 1973. *Daedalea quercina* forma *tremetea* in Illinois. Mycologia 65:689-690.

Scharrer, E. M. 1972. Relict prairie flora of southwestern Michigan. P. 9-12 *in* J. H. Zimmerman, ed. Proceedings of the Second Midwest Prairie Conference. University of Wisconsin, Madison.

Schwegman, J. 1977*a*. A different kind of treasure hunt. Illinois Parks and Recreation 8(6):6-7, 19.

Schwegman, J. 1977*b*. Natural Areas Inventory: A different kind of treasure hunt. Outdoor Highlights 5(12):5-8. [Illinois Department of Conservation, Springfield.]

Schwegman, J. E., G. B. Fell, M. Hutchison, G. Paulson, W. M. Shepherd, and J. White. 1973. Comprehensive plan for the Illinois Nature Preserves System, Part 2--The Natural Divisions of Illinois. Illinois Nature Preserves Commission, Rockford. 32 p. + map.

Shackleford, M. W. 1929. Animal communities of an Illinois prairie. Ecology 10:126-154.

Shepard, R. D. and W. R. Boggess. [1971.] The oak-hickory forest region of the eastern deciduous forest, including an inventory of significant natural areas. Natural landmarks theme study for the National Park Service. 196 p.

Shimek, B. 1913. An artificial prairie. Bulletin from the Laboratories of Natural History of the State University of Iowa 6(4):35-42.

Shimek, B. 1925. The persistence of the prairie. University of Iowa Studies in Natural History 11:3-24.

Short, C. W. 1854. Observations on the botany of Illinois, more especially in reference to the autumnal flora of the prairies. Western Journal of Medicine and Surgery, New Series 3:185-198.

Short, N. M., P. D. Lowman, Jr., S. C. Freden, and W. A. Finch, Jr. 1976. Mission to earth: Landsat views the world. National Aeronautics and Space Administration, Washington, D. C. 459 p.

Smith, P. W. 1961. The amphibians and reptiles of Illinois. Illinois Natural History Survey Bulletin 28:1-298.

Smith, P. W. 1971. Illinois streams: A classification based on their fishes and an analysis of factors responsible for disappearance of native species. Illinois Natural History Survey Biological Notes No. 76. 14 p.

Smith, P. W. 1973. A classification of aquatic environments of Illinois and a list of potential International Aquatic Scientific Areas. Report for the United States/International Biological Programme's Conservation of Aquatic Ecosystems, Freshwater Task Force. 34 p.

Smith, P. W. 1978. The fishes of Illinois. University of Illinois Press, Urbana. 314 p.

Smith, P. W. and P. W. Parmalee. 1954. Notes on distribution and habits of some bats from Illinois. Transactions of the Kansas Academy of Sciences 57:200-205.

Society of American Foresters. 1967. Forest cover types of North America (exclusive of Mexico). Washington, D. C. 67 p.

Starr, J. W., Jr. 1929. One hundred years of American railroading. Dodd, Mead, & Co., New York. 336 p.

Starrett, W. C. 1971. A survey of mussels (Unionacea) of the Illinois River: A polluted stream. Illinois Natural History Survey Bulletin 30:267-403.

Starrett, W. C. 1972. Man and the Illinois River. P. 131-169 *in* R. T. Oglesby, C. A. Carlson, and J. A. McCann, eds. River ecology and man. Academic Press, New York.

Stitt, R. R. 1977. Human impact on caves. P. 36-43 *in* T. Aley and D. Rhodes, eds. [Second] National Cave Management Symposium proceedings. Speleobooks, Albuquerque. 106 p.

Stover, J. F. 1975. History of the Illinois Central Railroad. Macmillan Publishing Co., New York. 575 p.

Strandberg, C. H. 1967. Aerial discovery manual. John Wiley and Sons, New York. 249 p.

Stupka, R. C., J. E. Brower, and J. Henriksen. 1972. New northwestern Illinois locality records for the western harvest mouse (*Reithrodontomys megalotis dychei*). Transactions of the Illinois State Academy of Science 65:112-114.

Tanner, H. S. 1840. A description of the canals and railroads of the United States comprehending notices of all the works of internal improvements throughout the several states. T. R. Tanner and J. Disturnell, New York. 272 p.

Tans, W. 1974. Priority ranking of biotic natural areas. Michigan Botanist 13:31-39.

Tans, W. E. 1972. An evaluation system for priority ranking of biotic natural areas. Wisconsin Department of Natural Resources, Madison. Form + 7 p. text.

Thompson, P. W. 1972. The preservation of prairie stands in Michigan. P. 13-14 *in* J. H. Zimmerman, ed. Proceedings of the Second Midwest Prairie Conference. University of Wisconsin, Madison.

Thomson, J. W., Jr. 1940. Relic prairie areas in central Wisconsin. Ecological Monographs 10:685-717.

Troutman, K. R. 1978. The prairie remnants of Marion, Crawford, and Wyandot counties in north central Ohio. P. 37 *in* Abstracts of contributed papers for the Sixth North American Prairie Conference. Ohio State University, Columbus.

U. S. Department of Agriculture, Economic Research Service. 1969. Airphoto use in resource management. Agricultural Information Service Bulletin 336. 26 p.

U. S. Department of the Army. 1969. Map reading. Field Manual 21-26. U. S. Government Printing Office, Washington, D. C. 114 p. + 4 maps.

U. S. Geological Survey. 1969. Topographic maps. U. S. Government Printing Office, Washington, D. C. 20 p.

Vestal, A. G. 1918. Invasion of forest land by prairie along railroads. Transactions of the Illinois State Academy of Science 11:126-128.

Vestal, A. G. 1931. Strategic habitats and communities in Illinois. Transactions of the Illinois State Academy of Science 24:80-85.

Vestal, A. G. 1934. Bibliography of the ecology of Illinois, Part I. Transactions of the Illinois State Academy of Science 27:163-261.

Wanless, H. R. 1969. Aerial stereo photographs. Hubbard Press, Northbrook, Illinois. 92 p.

Way, D. S. 1973. Terrain analysis: A guide to site selection using aerial photographic interpretation. Dowden, Hutchinson & Ross, Stroudsburg, Pennsylvania. 392 p.

White, J. 1973. Preservation of caves in Illinois. Report for the Illinois Nature Preserves Commission, Rockford. 11 p.

Wieting, H., Jr., S. Lukowski, N. Buckingham, M. Schamis, and J. Humke. 1977. Preserving our natural heritage. Volume I: Federal activities. Report by The Nature Conservancy for the U. S. Department of the Interior. Washington, D. C. 323 p.

Wilhelm, G. S. 1978. Kane County natural area survey. Kane County Urban Development Commission, Geneva, Illinois. 220 p.

Williams, R. S., Jr. and W. D. Carter, eds. 1976. ERTS-1, a new window on our planet. U. S. Geological Survey Professional Paper 929. 362 p.

Willman, H. B. and others. 1967. Geologic map of Illinois. Illinois State Geological Survey, Urbana. 1:500,000 scale map.

Willman, H. B., E. Atherton, T. C. Buschback, C. Collinson, J. C. Frye, M. E. Hopkins, J. A. Lineback, and J. A. Simon. 1975. Handbook of Illinois stratigraphy. Illinois State Geological Survey Bulletin 95. 261 p.

Willman, H. B., J. A. Simon, B. M. Lynch, and V. A. Langenheim. 1968. Bibliography and index of Illinois geology through 1965. Illinois State Geological Survey Bulletin 92. 373 p.

Wilson, T. 1978. A plant species inventory and evaluation of some prairie remnants in Waukesha County, Wisconsin. P. 39-45 *in* D. C. Glenn-Lewin and R. Q. Landers, Jr., eds. Fifth Midwest Prairie Conference proceedings. Iowa State University, Ames.

Worthen, A. J., director. 1866. Geological survey of Illinois, Volume 1, Geology. 504 p.

Wright, D. F. 1977. A site evaluation scheme for use in the assessment of potential nature reserves. Biological Conservation 11:293-305.

Zar, J. H. 1968. The fatty acid composition of the ladybird beetle, *Coleomegilla maculata* (DeGeer), during hibernation. Comparative Biochemistry and Physiology 26:1127-1129.

Zetek, J. 1918. The Mollusca of Piatt, Champaign, and Vermilion counties of Illinois. Transactions of the Illinois State Academy of Science 11:151-157.

PART VII
APPENDICES

Plate 9. *A cave in the Shawnee Hills. Over one thousand gray bats, an endangered species, use this room in the cave as a nursery in the summer. The cave has a beetle and a millipede known from no other locality in the world.*

Appendix 1.

NUMBER AND DISTRIBUTION OF NATURAL AREAS AND SIGNIFICANT FEATURES

This appendix supplements the discussion in Section 25. Table 4 gives the number of natural areas and significant features (by category) in each county (see Figure 2). Table 5 gives the number of natural areas and significant features (by category) in each Natural Division and Section (Appendix 30).

Table 4. Number of natural areas and significant features (by category) in each county.

County	Total areas	Significant features							
		All Cat.	Cat. I	Cat. II	Cat. III	Cat. IV	Cat. V	Cat. VI	Cat. VII
Adams	16	20	8	5	--	4	2	1	--
Alexander	22	34	5	18	--	7	3	--	1
Bond	2	2	1	--	--	1	--	--	--
Boone	3	3	1	--	--	--	2	--	--
Brown	5	5	4	--	--	1	--	--	--
Bureau	9	12	3	2	--	2	5	--	--
Calhoun	15	18	9	2	1	6	--	--	--
Carroll	15	25	5	9	1	4	4	1	1
Cass	8	9	5	3	--	1	--	--	--
Champaign	7	13	3	--	--	--	10	--	--
Christian	1	1	1	--	--	--	--	--	--
Clark	6	7	4	--	--	1	1	1	--
Clay	3	3	2	--	--	--	--	1	--
Clinton	3	3	2	1	--	--	--	--	--
Coles	15	16	7	2	1	2	4	--	--
Cook	60	108	49	23	--	3	31	2	--
Crawford	5	4	1	1	--	--	2	--	--
Cumberland	2	3	--	1	--	1	--	--	1
DeKalb	6	6	4	--	--	1	1	--	--
DeWitt	1	1	1	--	--	--	--	--	--
Douglas	2	2	2	--	--	--	--	--	--
DuPage	14	17	5	2	--	1	9	--	--
Edgar	2	3	1	--	--	--	2	--	--
Edwards	1	1	--	--	--	--	1	--	--
Effingham	6	6	1	--	--	1	4	--	--
Fayette	13	13	7	--	--	2	4	--	--
Ford	4	5	3	1	--	--	1	--	--
Franklin	3	2	1	--	--	--	1	--	--
Fulton	8	8	1	--	--	7	--	--	--
Gallatin	4	7	4	1	1	1	--	--	--
Greene	4	5	4	1	--	--	--	--	--
Grundy	9	13	8	2	--	2	1	--	--
Hamilton	--	--	--	--	--	--	--	--	--
Hancock	10	16	5	1	--	6	4	--	--
Hardin	23	35	17	7	-	4	2	4	1
Henderson	12	17	13	3	--	--	1	--	--
Henry	6	7	6	1	--	--	--	--	--
Iroquois	7	14	10	3	--	--	--	--	1
Jackson	34	49	9	19	6	6	8	1	--
Jasper	6	9	3	3	--	--	2	--	1
Jefferson	5	5	3	--	--	--	2	--	--
Jersey	10	14	6	1	--	4	2	1	--
Jo Daviess	14	30	2	16	1	9	--	--	2
Johnson	32	60	27	17	4	4	4	4	--
Kane	19	30	17	7	1	2	3	--	--
Kankakee	20	23	15	3	--	3	1	--	1
Kendall	6	8	4	3	--	--	1	--	--
Knox	5	5	3	--	--	1	1	--	--
Lake	50	178	42	108	5	--	19	1	3
LaSalle	18	33	9	7	5	8	3	1	--
Lawrence	5	6	4	--	--	1	1	--	--
Lee	19	22	9	6	--	5	2	--	--
Livingston	3	3	2	--	--	1	--	--	--
Logan	5	4	1	--	--	--	3	--	--
McDonough	4	4	4	--	--	--	--	--	--
McHenry	34	71	18	36	--	3	12	1	1
McLean	7	10	2	--	--	1	6	--	--
Macon	8	8	4	1	--	--	3	--	--
Macoupin	11	12	7	1	--	2	2	--	--
Madison	7	8	4	--	--	2	2	--	--

Table 4. Number of natural areas and significant features (by category) in each county, *continued*.

County	Total areas	Significant features							
		All Cat.	Cat. I	Cat. II	Cat. III	Cat. IV	Cat. V	Cat. VI	Cat. VII
Marion	8	9	5	1	--	--	3	--	--
Marshall.	5	5	4	--	--	--	1	--	--
Mason.	27	40	20	13	2	1	4	--	--
Massac	18	35	13	17	--	2	2	1	--
Menard	4	3	2	--	--	--	1	--	--
Mercer	4	4	2	1	--	--	1	--	--
Monroe	20	55	22	26	--	1	1	5	--
Montgomery	4	4	3	--	--	--	1	--	--
Morgan	2	3	1	1	--	--	1	--	--
Moultrie.	1	1	1	--	--	--	--	--	--
Ogle	20	41	10	17	3	5	5	--	1
Peoria	16	18	16	--	--	1	1	--	--
Perry.	7	7	5	1	--	--	1	--	--
Piatt.	2	5	2	--	--	--	3	--	--
Pike	23	27	18	2	--	6	1	--	--
Pope	47	88	23	44	11	3	6	--	1
Pulaski	9	18	1	9	--	5	2	1	--
Putnam	5	7	3	1	--	--	3	--	--
Randolph.	12	20	4	0	1	4	2	--	--
Richland.	2	2	--	--	--	--	2	--	--
Rock Island. . . .	12	13	7	3	--	2	1	--	--
St. Clair	22	28	20	4	--	2	1	1	--
Saline	9	12	6	1	--	3	1	1	--
Sangamon.	4	4	2	--	--	--	2	--	--
Schuyler.	3	3	2	--	--	1	--	--	--
Scott.	1	1	--	--	--	--	1	--	--
Shelby	--	--	--	--	--	--	--	--	--
Stark.	1	1	1	--	--	--	--	--	--
Stephenson	6	8	3	2	--	1	2	--	--
Tazewell.	14	18	8	3	2	1	3	--	1
Union.	23	49	17	19	--	7	3	2	1
Vermilion	15	19	8	3	--	2	3	1	2
Wabash	4	9	4	2	--	--	3	--	--
Warren	3	3	3	--	--	--	--	--	--
Washington	7	8	6	--	--	--	2	--	--
Wayne.	3	3	3	--	--	--	--	--	--
White.	--	--	--	--	--	--	--	--	--
Whiteside	8	10	5	2	--	--	3	--	--
Will	36	55	33	11	--	6	5	--	--
Williamson	14	15	--	3	--	1	11	--	--
Winnebago	36	56	14	24	--	1	16	1	--
Woodford.	8	10	5	2	--	--	2	--	1
Totals for entire state*	1089	1728	689	521	45	160	266	30	17

*The sum of the figures in each column does not equal the total for the entire state, because some natural areas and significant features occur in more than one county. In such instances, the areas and features are tabulated in each of the counties in which they occur. However, each natural area and significant feature is counted only once in the totals for the entire state.

Table 5. Number of natural areas and significant features (by category) in each Natural Division and Section.

	Natural Division/Section	Total areas	All Cat.	Cat. I	Cat. II	Cat. III	Cat. IV	Cat. V	Cat. VI	Cat. VII
			Significant features							
1.	Wisconsin Driftless	15	31	3	14	1	11	1	--	1
2a.	Rock River Hill Country/Freeport	35	54	17	13	3	4	16	1	--
2b.	Rock River Hill Country/Oregon	21	39	7	18	1	8	4	--	1
3a.	Northeastern Morainal/Morainal	159	341	108	146	6	10	66	2	3
3b.	Northeastern Morainal/L. Mich. Dunes	3	49	8	39	--	--	1	--	1
3c.	Northeastern Morainal/Chicago L. Plain	30	61	32	15	--	1	11	2	--
3d.	Northeastern Morainal/Winnebago Drift	26	37	7	18	--	1	9	1	1
4a.	Grand Prairie/Grand Prairie	154	198	94	21	6	22	52	1	2
4b.	Grand Prairie/Springfield	19	22	13	2	--	1	6	--	--
4c.	Grand Prairie/Western	3	4	3	1	--	--	--	--	--
4d.	Grand Prairie/Green River Lowland	8	9	6	2	--	--	1	--	--
4e.	Grand Prairie/Kankakee Sand Area	31	48	36	7	--	2	1	--	2
5a.	Upper Miss. R. & Ill. R. Bot./Ill. R.	17	19	10	6	--	--	2	--	1
5b.	Upper Miss. R. & Ill. R. Bot./Miss. R.	17	23	12	7	--	--	3	--	1
6a.	Ill. & Miss. R. Sand Areas/Ill. R.	27	41	19	14	4	1	3	--	--
6b.	Ill. & Miss. R. Sand Areas/Miss. R.	13	22	9	9	--	--	4	--	--
7a.	Western Forest--Prairie/Galesburg	39	40	25	2	--	12	1	--	--
7b.	Western Forest--Prairie/Carlinville	14	15	8	1	--	2	4	--	--
8a.	Middle Mississippi Border/Glaciated	69	86	44	9	--	20	11	2	--
8b.	Middle Mississippi Border/Driftless	18	24	10	3	1	9	1	--	--
9a.	So. Till Plain/Effingham Plain	56	61	33	6	--	6	15	--	1
9b.	So. Till Plain/Mt. Vernon Hill Country	59	62	28	7	1	3	22	1	--
10a.	Wabash Border/Bottomlands	14	19	10	4	--	1	3	--	1
10b.	Wabash Border/Southern Uplands	11	17	8	1	--	1	6	1	--
10c.	Wabash Border/Vermilion River	13	17	8	3	--	2	1	1	2
11a.	Ozark/Northern	28	68	29	27	--	6	1	5	--
11b.	Ozark/Central	5	8	1	5	1	--	1	--	--
11c.	Ozark/Southern	23	38	10	13	--	12	3	--	--
12a.	Lower Miss. R. Bottomlands/Northern	4	4	1	2	--	--	1	--	--
12b.	Lower Miss. R. Bottomlands/Southern	8	21	2	16	--	--	2	--	1
13a.	Shawnee Hills/Greater Shawnee Hills	76	119	31	40	16	14	15	2	1
13b.	Shawnee Hills/Lesser Shawnee Hills	49	72	37	12	1	8	4	8	2
14a.	Coastal Plain/Cretaceous Hills	17	44	2	26	4	7	5	--	--
14b.	Coastal Plain/Bottomlands	34	75	25	41	--	--	6	3	--
	Totals for entire state*	1089	1728	689	521	45	160	266	30	17

*The sum of the figures in each column does not equal the total for the entire state, because some natural areas and significant features occur in more than one Natural Division and Section. In such instances, the areas and features are tabulated in each of the Divisions and Sections in which they occur. However, each natural area and significant feature is counted only once in the totals for the entire state.

Appendix 2.

SUMMARIES OF NATURAL QUALITY, NATURAL COMMUNITIES, AND NATURAL DIVISIONS AND SECTIONS

Explanation of Table 6

Table 6 summarizes the results of the inventory from the standpoint of natural communities and natural quality. The Natural Divisions and Sections (*1* through *14b*) form the boxhead labeling each column. The Divisions and Sections are named in Figure 8 in Appendix 30.

The types of natural communities (*xeric upland forest* through *aquatic cave community*) identify the horizontal lines in the table. The intersection of each horizontal line with a column forms a box that is a possible occurrence of a natural community in a particular Section.

The left side of each box gives the number of acres of Grade A land or water identified by the Inventory in each natural community. The right side of each box gives the Grade B acreage.

If no Grade A or B examples of a natural community were found in a particular Section, but a Grade C example was included in a natural area, then a "C" appears in the center of the box for that natural community.

If a Grade A or B example was included in a natural area but the acreage was not measured, then a "P" for "present" appears instead of an acreage figure. Acreages were not figured for very small or discontinuous Grade A or B areas that were not mapped and did not qualify as significant features. Acreages are not included in this table for stream, cliff, overhang, and cave communities.

If there were no natural areas with Grade A, B, or C examples of a natural community in a Section, then the box has no figures or letters, but there is one of the following symbols:

Blank: Natural community does occur, or did occur, in the Section.

Light shading: Natural community may have occurred during presettlement times in the Section; or natural community may still

occur in the Section, but most likely is poorly developed or severely disturbed.

Dark shading: Natural community never occurred, or probably never occurred during presettlement times, in the Section.

Annotating the natural communities with dark, light, or blank symbols was a difficult task that required many uncertain choices. Our knowledge about natural communities that may no longer exist in Illinois is scant. Although judgements about the possible occurrence of communities were made on the basis of 3 years of experience with applying the classification system in the field, future work will no doubt result in changes in the annotations.

Explanation of Tables 7 and 8

The Grade A and B acreages are as accurate and complete as could be made, but some figures might be misinterpreted if the method of tabulating the acreages is not understood. As explained above for Table 6, all Grade A and B acreages that occurred in natural areas are tabulated, except for acreages of stream, cliff, overhang, and cave communities. Areas of Grade A and B forest, prairie, savanna, wetland, and pond communities that are too small to qualify as significant features are included in the tabulations only if they occurred in natural areas identified for some other significant feature. For example, 0.3 acre of Grade B forest are listed for Brown County only because a 0.3-acre stand of high quality forest was found in association with a hill prairie significant feature. There are many other very small stands of Grade B forest in Brown County, but they are not tabulated because they did not occur in natural areas. Similarly, most counties have at least some undisturbed cliff communities, but they are listed (under primary communities) only in counties where they occurred in natural areas.

Table 6. Summary of natural quality, natural communities, and Natural Divisions and Sections. Part A.

Natural Community	1 A	1 B	2a A	2a B	2b A	2b B	3a A	3a B	3b A	3b B	3c A	3c B	3d A	3d B	4a A	4a B
FOREST																
Xeric upland forest																
Dry upland forest	C				C										--	27
Dry-mesic upland forest	C		--	114	--	20	189	615			C		C		235	481
Mesic upland forest	C		--	20	C		176	503			C		C		520	437
Wet-mesic upland forest							--	50			C					
Dry sand forest																
Dry-mesic sand forest											C					
Mesic sand forest																
Mesic floodplain forest	C		C		C		4.4	70							--	7.0
Wet-mesic floodplain forest			C		C		--	26					C		73	244
Wet floodplain forest			C		C		--	32			C		C		17	146
Northern flatwoods							--	86								
Southern flatwoods																
Sand flatwoods											--	21				
PRAIRIE																
Dry prairie	C		C										C		1.0	--
Dry-mesic prairie			1.0	--			0.6	8.2			1.3	3.0	--	2.0	3.3	13
Mesic prairie			0.6	0.5			25	62	3.8	1.9	9.5	31	--	2.0	14	94
Wet-mesic prairie			1.9	3.1	C		1.4	15			22	43			--	7.5
Wet prairie			--	8.0			--	4.6	--	3.1	12	73			--	10
Dry sand prairie					C				122	16			C			
Dry-mesic sand prairie			0.4	0.6					219	20	14	21				
Mesic sand prairie									55	38	9.0	44	C			
Wet-mesic sand prairie									14	7.0	--	12				
Wet sand prairie									79	60	--	6.5				
Dry gravel prairie			--	1.0	P	--	3.0	9.2					0.4	5.2		
Dry-mesic gravel prairie			--	11			--	2.4			1.0	1.2	8.5	19		
Mesic gravel prairie											8.9	9.7				
Dry dolomite prairie	P	--	4.1	5.4			C						C		--	1.5
Dry-mesic dolomite prairie							1.0	3.0							--	4.2
Mesic dolomite prairie							1.0	3.0								
Wet-mesic dolomite prairie							--	14								
Wet dolomite prairie							--	5.0								
Loess hill prairie	--	2.5													--	1.8
Glacial drift hill prairie					--	0.3									10	19
Gravel hill prairie							--	0.5								
Sand hill prairie	1.6	0.5														
Shrub prairie											--	3.1	C			
SAVANNA																
Dry-mesic savanna	C						C				C				--	4.0
Mesic savanna							--	2.0	C							
Dry sand savanna			C						111	10			C			
Dry-mesic sand savanna									13	19	29	3.4				
Dry barren															--	1.0
Dry-mesic barren							C								--	0.5
Mesic barren																

Natural Community	4b A	4b B	4c A	4c B	4d A	4d B	4e A	4e B	5a A	5a B	5b A	5b B	6a A	6a B	6b A	6b B	7a A	7a B	7b A	7b B
FOREST																				
Xeric upland forest																				
Dry upland forest																				
Dry-mesic upland forest	26	129					C										17	86	32	81
Mesic upland forest	149	20					--	20									--	28	C	
Wet-mesic upland forest															C		--	11		
Dry sand forest													83	37						
Dry-mesic sand forest							C						16	--						
Mesic sand forest													--	10						
Mesic floodplain forest																	C			
Wet-mesic floodplain forest	94	3.0					9.0	--	--	20	--	1586	C				C			
Wet floodplain forest	C		C				5.0	--	C		--	1801					C		C	
Northern flatwoods																				
Southern flatwoods																				
Sand flatwoods							C													
PRAIRIE																				
Dry prairie					0.3	0.1														
Dry-mesic prairie			--	7.0							1.1	0.7					1.3	3.6	0.8	7.7
Mesic prairie							--	20			--	0.7					1.1	5.2		
Wet-mesic prairie	--	1.1					--	24			0.7	1.7					--	2.8		
Wet prairie							--	0.5	--	42	--	28							C	
Dry sand prairie					C		--	0.2					--	107	--	170				
Dry-mesic sand prairie					2.7	0.6	1.3	7.6					--	10	19	20				
Mesic sand prairie							5.0	7.8					C							
Wet-mesic sand prairie					0.3	--	1.2	7.1					C							
Wet sand prairie							--	0.1					--	17	C					
Dry gravel prairie																				
Dry-mesic gravel prairie																				
Mesic gravel prairie																				
Dry dolomite prairie																				
Dry-mesic dolomite prairie																				
Mesic dolomite prairie																				
Wet-mesic dolomite prairie																				
Wet dolomite prairie																				
Loess hill prairie	23	35															--	2.0		
Glacial drift hill prairie																				
Gravel hill prairie													0.9	2.0						
Sand hill prairie																				
Shrub prairie							--	57												
SAVANNA																				
Dry-mesic savanna																	0.3	1.4		
Mesic savanna																				
Dry sand savanna							7.0	476					--	105	C					
Dry-mesic sand savanna							11	448					C		C					
Dry barren																	--	14		
Dry-mesic barren																				
Mesic barren																				

Table 6. Summary of natural quality, natural communities, and Natural Divisions and Sections. Part B.

Natural Community	Natural Division and Section																																			
	1		2a		2b		3a		3b		3c		3d		4a		4b		4c		4d		4e		5a		5b		6a		6b		7a		7b	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
WETLAND																																				
Marsh			--	0.7	--	1.2	250	714	31	667	12	44	C		C								--	12	--	28	--	356	C				--	7.2	--	13
Brackish marsh															C																					
Swamp																																				
Shrub swamp			--	5.5			1.6	0.4					C										1.0	3.5	--	3.9	--	11	--	2.2			--	5.0	--	11
Graminoid bog							6.9	2.8																												
Low shrub bog							21	7.5																												
Tall shrub bog							45	50																												
Forested bog							31	68																												
Calcareous floating mat							107	60																												
Graminoid fen							64	58	1.3	--	1.3	8.1			C																					
Low shrub fen							0.4	--							C																					
Tall shrub fen																									5.0	--										
Forested fen							--	15																												
Sedge meadow			C				114	191	39	9.5	2.2	50	--	8.0	--	4.5							--	270	C											
Panne									54	3.2																										
Seep	P	--			1.9	0.6	1.9	12							1.0	P									--	41			20	7.5			--	0.3		
Acid gravel seep																																				
Calcareous seep	P	--					12	1.5																												
Sand seep											--	7.0											--	2.7												
Spring community							P	--																												
LAKE & POND																																				
Pond	C		1.2	7.3			57	163	4.4	--			2.5	P	C		--	35					1.0	3.5	C		--	73	--	3.1					--	52
Lake							--	837																	C						C					
Great lake							C		C																											
STREAM																																				
Low-gradient creek	--	P	C		C		--	P	P	--					C										C											
Medium-gradient creek							--	P			C				C		C												C				C			
High-gradient creek	--	P	C		C		C						--	P	--	P																	C			
Low-gradient river			P	--			C						--	P	--	P	C						--	P	C								C			
Medium-gradient river					--	P	C						--	P	--	P							--	P												
Major river															C										C		C									
PRIMARY																																				
Sandstone glade																																				
Limestone glade																																				
Shale glade																																	C			
Sandstone cliff community					P	P																											--	P		
Limestone cliff community	P	--																															P	--		
Dolomite cliff community	P	--	P	--			P	P					P	--	P	P							--	P												
Sandstone overhang community															P	P																				
Eroding bluff community			P	--			10	1.0			P	--			6.0	P																	P	4.0		
Beach							C		48	15																										
Foredune									86	19																										
CAVE																																				
Terrestrial cave community	P	P					C								--	P																				
Aquatic cave community																																				
TOTAL ACREAGES FOR ALL COMMUNITIES	1.6	3.0	9.2	177	1.9	22	1123	3692	830	889	122	381	11	36	881	1503	292	223	--	7.0	3.3	0.7	42	1360	5.0	135	1.8	3858	120	301	19	190	20	170	33	165

Table 6. Summary of natural quality, natural communities, and Natural Divisions and Sections. Part C.

Natural Community	8a A	8a B	8b A	8b B	9a A	9a B	9b A	9b B	10a A	10a B	10b A	10b B	10c A	10c B	11a A	11a B	11b A	11b B	11c A	11c B	12a A	12a B	12b A	12b B	13a A	13a B	13b A	13b B	14a A	14a B	14b A	14b B	TOTAL A	TOTAL B
FOREST																																		
Xeric upland forest																			P	--					11	75							11	75
Dry upland forest	C		C		9.0	14	--	26					C		14	23	C		--	33					286	106	24	105	C				333	334
Dry-mesic upland forest	--	73	30	--	103	80	92	120			163	62	--	19	59	86	C		C						--	35	40	70	--	13	C		986	2084
Mesic upland forest	31	52	C		42	139	C				43	74	--	17	14	15	C		C						20	35	63	113	--	P			1058	1473
Wet-mesic upland forest	C																																--	61
Dry sand forest																																	83	37
Dry-mesic sand forest																																	16	--
Mesic sand forest																																	--	10
Mesic floodplain forest							2.0	6.5			C		C						--	10			C		C		C		C		30	80	36	174
Wet-mesic floodplain forest	C		--	7.0	91	158	30	0.8	81	35	83	35	C		36	--	C						C		C				--	P	--	502	497	2617
Wet floodplain forest	C		C		214	153	44	4.2	--	44											C		C		C		C		C		56	342	336	2522
Northern flatwoods																																	--	86
Southern flatwoods					120	216	203	95	C						C																C		323	311
Sand flatwoods																																	--	21
PRAIRIE																																		
Dry prairie																																	1.3	0.1
Dry-mesic prairie			C		--	3.1	--	1.2																									9.4	50
Mesic prairie					0.3	2.3	C																										54	220
Wet-mesic prairie					--	1.2	C																										26	99
Wet prairie																																	12	169
Dry sand prairie																																	122	293
Dry-mesic sand prairie	--	1.0																															256	81
Mesic sand prairie																																	69	90
Wet-mesic sand prairie																																	16	26
Wet sand prairie																																	79	84
Dry gravel prairie																																	3.4	15
Dry-mesic gravel prairie																																	9.5	34
Mesic gravel prairie																																	8.9	9.7
Dry dolomite prairie																																	4.1	6.9
Dry-mesic dolomite prairie																																	1.0	7.2
Mesic dolomite prairie																																	1.0	3.0
Wet-mesic dolomite prairie																																	--	14
Wet dolomite prairie																																	--	5.0
Loess hill prairie	34	72	0.4	24											93	77			7.7	--					--	0.1							158	214
Glacial drift hill prairie	--	0.7					0.6	--					3.8	0.3			C																14	29
Gravel hill prairie																																	0.9	2.5
Sand hill prairie																																	1.6	0.5
Shrub prairie																																	--	60
SAVANNA																																		
Dry-mesic savanna						2.0							--	1.5																			0.3	8.9
Mesic savanna																																	--	2.0
Dry sand savanna																																	118	591
Dry-mesic sand savanna																																	53	470
Dry barren	--	5.5			C														2.3	--					9.7	17			C				12	24
Dry-mesic barren	C														C														C				--	18
Mesic barren																											--	2.0					--	2.0

Table 6. Summary of natural quality, natural communities, and Natural Divisions and Sections. Part D.

Natural Community	8a		8b		9a		9b		10a		10b		10c		11a		11b		11c		12a		12b		13a		13b		14a		14b		TOTAL	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
WETLAND																																		
Marsh					C				17	77											C												310	1920
Brackish marsh																																	C	
Swamp																															354	1724	354	1724
Shrub swamp					7.0	7.0	3.8	40	3.5	3.6											--	30	--	30							--	128	17	281
Graminoid bog																																	6.9	2.8
Low shrub bog																																	21	7.5
Tall shrub bog																																	45	50
Forested bog																																	31	68
Calcareous floating mat																																	107	60
Graminoid fen																																	67	66
Low shrub fen																																	0.4	--
Tall shrub fen																																	5.0	--
Forested fen																																	--	15
Sedge meadow																																	155	533
Panne																																	54	3.2
Seep					--	P	--	1.5					6.7	--																			31	63
Acid gravel seep																													--	6.0			--	6.0
Calcareous seep													1.5	--																			13	1.5
Sand seep	C																																--	9.7
Spring community																			--	1.0									C		--	P	--	1.0
LAKE & POND																																		
Pond					58	35	25	374	56	27					1.8	P					--	63	--	74							C		204	919
Lake																															2	9	--	837
Great lake																																	C	
STREAM																																		
Low-gradient creek	--	P			C		C		C		C				C								--	P			P	P			C		P	P
Medium-gradient creek	--	P			P	P	C				--	P													P	P	P	--					P	P
High-gradient creek	--	P													P	--	--	P	--	P					P	P	P	--					P	P
Low-gradient river					--	P	--	P	P	--													--	P							--	P	P	P
Medium-gradient river													P	P																			P	P
Major river									C																								C	
PRIMARY																																		
Sandstone glade																	7.0	2.0							140	55	10	--					157	57
Limestone glade	6.0	5.8	--	26											15	64			9.0	--					5.2	0.6	45	7.1					80	104
Shale glade																			4.3	0.7					P	--							4.3	0.7
Sandstone cliff community			P	--	P	--	P	P			P	--					P	P							P	P	P	--					P	P
Limestone cliff community	P	P	P	--											P	P			P	P					P	--	P	--					P	P
Dolomite cliff community			P	--																													P	P
Sandstone overhang community			P	--																					P	P	P	P					P	P
Eroding bluff community	P												6.5	3.0															P	--			22	8
Beach																																	48	15
Foredune																																	86	19
CAVE																																		
Terrestrial cave community	P	P	P	--											P	P			P	P					--	P	P	P					P	P
Aquatic cave community			P	--											P	P			P	--					P	--	P	P					P	P
TOTAL ACREAGES FOR ALL COMMUNITIES	71	210	30	57	639	810	400	669	158	187	289	171	18	41	233	265	7.0	2.0	23	45	--	93	--	104	472	324	182	297	--	19	442	2785	25,723	

Table 7. Acreage of Grade A & B land and water identified by the Inventory in each Natural Division and Section.

Natural Division/Section		Total acreage of section	Grade A & B acreage
1.	Wisconsin Driftless	371,000	3.6
2a.	Rock River Hill Country/Freeport	1,316,000	186
2b.	Rock River Hill Country/Oregon	142,000	24
3a.	Northeastern Morainal/Morainal	1,641,000	4815
3b.	Northeastern Morainal/L. Mich. Dunes	17,000	1769
3c.	Northeastern Morainal/Chicago L. Plain	340,000	503
3d.	Northeastern Morainal/Winnebago Drift	439,000	47
4a.	Grand Prairie/Grand Prairie	9,531,000	2384
4b.	Grand Prairie/Springfield	2,041,000	515
4c.	Grand Prairie/Western	602,000	7.0
4d.	Grand Prairie/Green River Lowland	506,000	4.0
4e.	Grand Prairie/Kankakee Sand Area	312,000	1402
5a.	Upper Miss. R. & Ill. R. Bot./Ill. R.	762,000	140
5b.	Upper Miss. R. & Ill. R. Bot./Miss. R.	609,000	3860
6a.	Ill. & Miss. R. Sand Areas/Ill. R.	282,000	421
6b.	Ill. & Miss. R. Sand Areas/Miss. R.	89,000	209
7a.	Western Forest--Prairie/Galesburg	3,217,000	190
7b.	Western Forest--Prairie/Carlinville	1,205,000	198
8a.	Middle Mississippi Border/Glaciated	1,425,000	281
8b.	Middle Mississippi Border/Driftless	205,000	87
9a.	So. Till Plain/Effingham Plain	3,793,000	1449
9b.	So. Till Plain/Mt. Vernon Hill Country	3,453,000	1069
10a.	Wabash Border/Bottomlands	890,000	345
10b.	Wabash Border/Southern Uplands	480,000	460
10c.	Wabash Border/Vermilion River	247,000	59
11a.	Ozark/Northern	172,000	507
11b.	Ozark/Central	116,000	--
11c.	Ozark/Southern	103,000	68
12a.	Lower Miss. R. Bottomlands/Northern	242,000	93
12b.	Lower Miss. R. Bottomlands/Southern	146,000	104
13a.	Shawnee Hills/Greater Shawnee Hills	535,000	796
13b.	Shawnee Hills/Lesser Shawnee Hills	434,000	479
14a.	Coastal Plain/Cretaceous Hills	162,000	19
14b.	Coastal Plain/Bottomlands	271,000	3227

Table 8. Acreage of Grade A & B land and water, by community class, identified by the Inventory in each county.

County	Forest	Prairie	Savanna	Wetland	Lake & Pond	Stream	Primary	Cave	Total
Adams.	2480	3.0	9.0	0.1	--	--	P	--	2492
Alexander.	271	5.0	--	47	--	--	--	--	323
Bond	--	--	--	--	22	--	--	--	22
Boone.	--	2.0	--	--	--	P	P	--	2.0
Brown.	0.3	4.9	--	--	--	--	--	--	5.2
Bureau	114	1.3	--	--	--	--	--	--	115
Calhoun.	213	20	--	--	--	--	26	--	259
Carroll.	--	52	--	--	--	--	P	--	52
Cass	--	44	--	6.2	3.1	--	--	--	53
Champaign.	148	--	--	--	--	--	--	--	148
Christian.	17	--	--	--	--	--	--	--	17
Clark.	147	--	--	--	--	P	P	--	147
Clay	--	1.2	--	--	48	--	P	--	49
Clinton.	46	--	--	--	0.7	--	--	--	47
Coles.	57	3.1	--	1.0	--	--	--	--	61
Cook	357	391	32	165	--	--	P	--	945
Crawford	20	--	--	--	--	--	--	--	20
Cumberland	--	--	--	--	--	P	--	--	P
DeKalb	--	7.5	--	--	--	--	--	--	7.5
DeWitt	44	--	--	--	--	--	--	--	44
Douglas.	28	1.0	--	--	--	--	--	--	29
DuPage	164	20	--	--	--	--	P	--	184
Edgar.	44	--	--	--	--	--	--	--	44
Edwards.	--	--	--	--	--	--	--	--	--
Effingham.	--	--	1.0	--	--	--	P	--	1.0
Fayette.	238	3.1	--	1.1	2.0	--	--	--	244
Ford	--	6.4	--	--	--	--	--	--	6.4
Franklin	P	--	--	--	--	--	--	--	P
Fulton	35	--	--	--	--	--	P	--	35
Gallatin	4.0	--	--	3.5	14	--	23	--	44
Greene	20	12	--	--	--	--	P	P	32
Grundy	--	5.3	--	--	--	--	P	--	5.3
Hancock.	P	1.9	5.5	--	--	P	P	--	7.4
Hardin	148	--	--	--	--	P	45	P	193
Henderson.	194	176	--	302	--	--	P	--	672
Henry.	--	9.7	--	--	--	--	--	--	9.7
Iroquois	--	48	360	218	--	--	--	--	626
Jackson.	--	1.6	--	40	370	P	17	P	429
Jasper	127	--	--	--	--	P	--	--	127
Jefferson.	44	--	--	--	4.5	--	P	--	48
Jersey	--	51	--	--	--	P	12	P	63
Jo Daviess	--	2.1	--	P	--	P	P	--	2.1
Johnson.	703	--	--	1667	2.0	P	109	P	2481
Kane	260	5.1	--	132	30	--	P	--	427
Kankakee	34	7.8	482	3.5	3.5	P	P	P	531
Kendall.	--	8.6	--	4.5	--	--	--	--	13
Knox	34	0.5	0.7	--	--	--	--	--	35
Lake	639	670	155	1645	931	P	180	--	4220
LaSalle.	176	1.3	1.0	P	--	--	6.0	--	184
Lawrence	97	--	--	94	--	--	--	--	191
Lee.	--	8.8	--	1.8	--	--	P	--	11
Livingston	--	2.4	--	--	--	--	--	--	2.4
Logan.	149	--	--	--	--	--	--	--	149
McDonough.	--	--	6.0	12	--	--	P	--	18
McHenry.	--	9.2	--	741	100	P	--	--	850
McLean	439	5.0	--	--	--	P	P	--	444
Macon.	161	--	--	--	35	--	--	--	196
Macoupin	93	8.5	--	52	24	--	--	--	178
Madison.	67	1.0	--	30	63	--	P	--	161

Table 8. Acreage of Grade A & B land and water, by community class, identified by the Inventory in each county, *continued.*

County	Forest	Prairie	Savanna	Wetland	Lake & Pond	Stream	Primary	Cave	Total
Marion	60	2.7	--	2.6	8.4	--	--	--	74
Marshall	--	5.7	--	27	--	--	--	--	33
Mason.	202	186	105	7.5	--	--	--	--	500
Massac	486	--	--	227	--	--	--	--	713
Menard	--	3.6	--	--	--	--	--	--	3.6
Mercer	--	1.0	--	8.0	--	--	--	--	9.0
Monroe	100	159	--	--	1.8	P	78	P	339
Montgomery	--	1.1	1.0	--	--	--	--	--	2.1
Morgan	--	11	--	--	--	--	--	--	11
Moultrie	18	--	--	--	--	--	--	--	18
Ogle	74	15	--	1.9	--	P	P	--	91
Peoria	227	14	4.0	--	--	--	--	--	245
Perry.	97	--	--	1.2	17	--	P	--	115
Piatt.	624	--	--	--	--	--	--	--	624
Pike	554	22	--	11	73	--	0.3	P	660
Pope	148	--	29	93	--	P	49	P	319
Pulaski.	--	--	--	173	--	P	P	P	173
Putnam	16	1.3	--	36	--	--	--	--	53
Randolph	76	10	--	--	--	P	2.0	--	88
Richland	--	--	--	--	--	--	--	--	--
Rock Island.	89	5.6	--	46	--	--	--	--	141
St. Clair.	968	3.6	--	12	62	P	1.0	P	1047
Saline	359	0.1	--	--	--	--	27	--	386
Sangamon	209	1.1	--	--	--	--	--	--	210
Schuyler	39	--	--	--	--	--	4.0	--	43
Scott.	--	--	--	--	--	--	--	--	--
Stark.	37	--	--	--	--	--	--	--	37
Stephenson	--	5.3	--	--	--	--	P	--	5.3
Tazewell	51	4.7	--	24	--	--	--	--	80
Union.	55	1.0	2.3	67	83	P	5.0	P	213
Vermilion.	36	4.1	1.5	8.2	--	P	9.5	--	59
Wabash	406	--	--	--	--	--	P	--	406
Warren	--	5.4	--	--	--	--	--	--	5.4
Washington	304	--	--	--	--	--	--	--	304
Wayne.	32	--	--	4.6	22	--	--	--	59
Whiteside.	--	21	--	--	--	--	--	--	21
Will	353	206	101	142	1.0	P	P	--	803
Williamson	--	--	--	--	--	--	P	--	P
Winnebago.	80	50	--	14	11	P	P	--	155
Woodford	--	1.6	3.2	6.3	--	P	--	--	11

Appendix 3.
RARE, THREATENED, AND ENDANGERED SPECIES

Animals listed by the Endangered Species Protection Board as endangered or threatened are in Tables 9 to 12. Plants recommended by the Endangered Species Project for endangered or threatened status are in Table 13. Other species are listed if the Inventory identified significant features or exceptional features for them. These additional animals and plants can generally be termed *rare*, as explained in Section 17.

The animals are listed alphabetically by common name, and the plants are listed alphabetically by scientific name. With few exceptions, scientific nomenclature follows Smith (1978) for fishes, Smith (1961) for amphibians and reptiles, Bohlen (1978) for birds, Jones, et al. (1975) for mammals, and Mohlenbrock (1975) for plants.

The Inventory considered many more animals as significant features and exceptional features than the Endangered Species Protection Board listed as endangered or threatened. The Inventory listed waterfowl that have a very limited breeding range in Illinois, but these game species were not included on the State's official list.

For plants, the Inventory's significant features generally coincide with the *endangered* category of the Natural Land Institute's Endangered Species Project (NLI); and the Inventory's exceptional features include many other species, including many that were considered too common by the NLI to be designated as *threatened*. There are occasional differences between the way in which the NLI classified a species and the way the Inventory treated it. For example, the white lady's slipper orchid was listed as endangered by the NLI, but it is known from so many locations that the Inventory considered it an exceptional feature and only listed it in the 14 areas where it occurs with other, significant features. Water featherfoil was deleted from the NLI's final list, but it was listed as a significant feature even though it is known from seven sites, because some of the populations are not likely to maintain themselves.

Sometimes one species is considered both a significant feature and an exceptional feature. For example, the rusty cotton grass is a significant feature at the two sites where it is known to occur; and it was listed as an exceptional feature at a third site, where it may still occur but has not been collected for 30 years. In this case, the cotton grass is not the *significant* feature--the reason for listing the site in the inventory--but its possible presence is an *exceptional* feature that adds value to the area.

Table 9. Rare, threatened, and endangered fishes. For each species, the status according to the Illinois Endangered Species Protection Board is given: state endangered (E), state threatened (T), or federally endangered (*). The numbers of significant features (SF's) and exceptional features (EF's) recognized by the Inventory are also given.

Common name	Scientific name	Status	SF	EF
Alligator gar	*Lepisosteus spatula*	T	-	-
Banded killifish	*Fundulus diaphanus*	-	-	4
Banded pygmy sunfish	*Elassoma zonatum*	-	-	2
Bantam sunfish	*Lepomis symmetricus*	T	1	-
Bigeye chub	*Hybopsis amblops*	E	-	1
Bigeye shiner	*Notropis boops*	-	-	2
Blackchin shiner	*Notropis heterodon*	-	-	4
Blacknose shiner	*Notropis heterolepis*	T	-	4
Blacktail shiner	*Notropis venustus*	-	-	1
Bluebreast darter	*Etheostoma camurum*	E	1	-
Bluehead shiner	*Notropis* sp. (undescribed)	E	1	-
Cisco	*Coregonus artedii*	T	-	-
Eastern sand darter	*Ammocrypta pellucida*	-	-	2
Harlequin darter	*Etheostoma histrio*	E	1	-
Ironcolor shiner	*Notropis chalybaeus*	-	-	2
Lake sturgeon	*Acipenser fulvescens*	T	-	-
Lake whitefish	*Coregonus clupeaformis*	T	-	-
Least brook lamprey	*Lampetra aepyptera*	-	-	1
Longjaw cisco	*Coregonus alpenae*	E*	-	-
Longnose sucker	*Catostomus catostomus*	T	-	-
Northern brook lamprey	*Ichthyomyzon fossor*	-	-	1
Northern madtom	*Noturus stigmosus*	-	-	2
Pallid shiner	*Notropis amnis*	-	-	1
Pugnose shiner	*Notropis anogenus*	T	3	-
River redhorse	*Moxostoma carinatum*	-	-	2
Spotted sunfish	*Lepomis punctatus*	-	-	2
Spring cavefish	*Chologaster agassizi*	-	-	5
Starhead topminnow	*Fundulus dispar*	-	-	6
Weed shiner	*Notropis texanus*	-	-	2

Table 10. Rare, threatened, and endangered amphibians and reptiles. For each species, the status according to the Illinois Endangered Species Protection Board is given: state endangered (E), or state threatened (T). The numbers of significant features (SF's) and exceptional features (EF's) recognized by the Inventory are also given.

Common name (and scientific name)	Status	SF	EF
Blanding's turtle (*Emydoidea blandingi*)	-	-	8
Blue-spotted salamander (*Ambystoma laterale*)	-	-	4
Broad-banded water snake (*Nerodia fasciata confluens*)	E	-	-
Eastern coachwhip snake (*Masticophis flagellum flagellum*)	T	3	-
Eastern massasauga (*Sistrurus catenatus catenatus*)	-	-	4
Eastern narrow-mouthed toad (*Gastrophryne carolinensis*)	-	-	3
Eastern ribbon snake (*Thamnophis sauritus sauritus* X *T. sauritus septentrionalis*)	E	-	-
Eastern spadefoot toad (*Scaphiopus holbrooki holbrooki*)	-	-	1
Flat-headed snake (*Tantilla gracilis*)	-	4	-
Four-toed salamander (*Hemidactylium scutatum*)	-	-	2
Great Plains rat snake (*Elaphe guttata emoryi*)	T	4	-
Green treefrog (*Hyla cinerea*)	-	-	4
Green water snake (*Nerodia cyclopion cyclopion*)	-	1	-
Illinois chorus frog (*Pseudacris streckeri illinoensis*)	T	4	1
Illinois mud turtle (*Kinosternon flavescens spooneri*)	E	2	-
Mole salamander (*Ambystoma talpoideum*)	-	-	4
Pickerel frog (*Rana palustris*)	-	-	4
Silvery salamander (*Ambystoma platineum*)	E	1	-
Slider (*Chrysemys concinna hieroglyphica* X *C. floridana hoyi*)	E	-	-
Spotted dusky salamander (*Desmognathus fuscus conanti*)	E	2	-
Spotted turtle (*Clemmys guttata*)	E	-	-
Timber rattlesnake (*Crotalus horridus*)	-	-	12
Western bird-voiced treefrog (*Hyla avivoca avivoca*)	-	-	5
Western hog-nosed snake (*Heterodon nasicus gloydi*)	T	-	6
Western mud snake (*Farancia abacura reinwardi*)	-	-	5
Western slender glass lizard (*Ophisaurus attenuatus attenuatus*)	-	-	1
Wood frog (*Rana sylvatica*)	-	-	3

Table 11. Rare, threatened, and endangered birds. For each species, the status according to the Illinois Endangered Species Protection Board is given: state endangered (E), state threatened (T), or federally endangered (*). The numbers of significant features (SF's) and exceptional features (EF's) recognized by the Inventory are also given.

Common name	Scientific name	Status	SF	EF
American bittern	*Botaurus lentiginosus*	E	-	5
Bachman's sparrow	*Aimophila aestivalis*	E	-	-
Bachman's warbler	*Vermivora bachmanii*	E*	-	-
Bald eagle	*Haliaeetus leucocephalus*	E	4	9
Barn owl	*Tyto alba*	E	-	-
Bewick's wren	*Thryomanes bewickii*	T	-	-
Black-crowned night heron	*Nycticorax nycticorax*	E	-	5
Black duck	*Anas rubripes*	-	-	4
Black rail	*Laterallus jamaicensis*	E	-	-
Black tern	*Chlidonias niger*	E	-	5
Brewer's blackbird	*Euphagus cyanocephalus*	T	-	4
Broad-winged hawk	*Buteo platypterus*	-	-	1
Brown creeper	*Certhia familiaris*	E	-	6
Canvasback	*Aythya valisineria*	-	-	3
Common gallinule	*Gallinula chloropus*	T	-	3
Common snipe	*Capella gallinago*	-	-	5
Common tern	*Sterna hirundo*	E	1	4
Cooper's hawk	*Accipiter cooperii*	E	-	-
Double-crested cormorant	*Phalacrocorax auritus*	E	1	-
Eskimo curlew	*Numenius borealis*	E*	-	-
Forster's tern	*Sterna forsteri*	E	-	3
Great egret	*Casmerodius albus*	E	5	1
Greater prairie chicken	*Tympanuchus cupido*	E	2	-
Henslow's sparrow	*Ammodramus henslowii*	T	-	5
Herring gull	*Larus argentatus*	-	-	1
Hooded merganser	*Lophodytes cucullatus*	-	-	2
King rail	*Rallus elegans*	-	-	6
Least bittern	*Ixobrychus exilis*	-	-	7
Least tern	*Sterna albifrons*	E	-	-
Little blue heron	*Florida caerulea*	E	1	-
Loggerhead shrike	*Lanius ludovicianus*	T	-	-
Long-eared owl	*Asio otus*	E	-	-
Marsh hawk	*Circus cyaneus*	E	-	1
Mississippi kite	*Ictinia mississippiensis*	E	3	1
Mourning warbler	*Oporornis philadelphia*	-	-	2
Nashville warbler	*Vermivora ruficapilla*	-	-	2
Northern shoveler	*Anas acuta*	-	-	4
Osprey	*Pandion haliaetus*	E	-	-
Peregrine falcon	*Falco peregrinus*	E*	-	2

Table 11. Rare, threatened, and endangered birds, *continued.*

Common name	Scientific name	Status	SF	EF
Pintail	*Anas acuta*	-	-	5
Piping plover	*Charadrius melodus*	E	-	3
Purple gallinule	*Porphyrula martinica*	E	1	3
Red-shouldered hawk	*Buteo lineatus*	E	-	3
Ring-billed gull	*Larus delawarensis*	-	-	2
Short-eared owl	*Asio flammeus*	E	-	2
Snowy egret	*Egretta thula*	E	1	-
Swainson's hawk	*Buteo swainsoni*	E	-	-
Swainson's warbler	*Limnothlypis swainsonii*	T	-	4
Upland sandpiper	*Bartramia longicauda*	E	-	8
Veery	*Catharus fuscescens*	T	-	4
Virginia rail	*Rallus limicola*	-	-	8
Wilson's phalarope	*Steganopus tricolor*	E	1	1
Yellow-crowned night heron	*Nyctanassa violacea*	-	-	3
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	E	-	7
Yellow rail	*Coturnicops noveboracensis*	E	-	1

Table 12. Rare, threatened, and endangered mammals. For each species, the status according to the Illinois Endangered Species Protection Board is given: state endangered (E), state threatened (T), or federally endangered (*). The numbers of significant features (SF's) and exceptional features (EF's) recognized by the Inventory are also given.

Common name	Scientific name	Status	SF	EF
Bobcat	*Felis rufus*	T	-	2
Cotton mouse	*Peromyscus gossypinus*	-	-	1
Eastern wood rat	*Neotoma floridana*	E	2	-
Golden mouse	*Ochrotomys nuttalli*	T	-	1
Gray bat	*Myotis grisescens*	E*	4	-
Indiana bat	*Myotis sodalis*	E*	1	1
Red squirrel	*Tamiasciurus hudsonicus*	-	-	3
Rice rat	*Oryzomys palustris*	T	-	4
River otter	*Lutra canadensis*	T	3	3
Southeastern bat	*Myotis austroriparius*	-	-	3
Southeastern big-eared bat	*Plecotus rafinesquii*	-	-	1
Swamp rabbit	*Sylvilagus aquaticus*	-	-	6
White-tailed jackrabbit	*Lepus townsendii*	E	1	-

Table 13. Rare, threatened, and endangered vascular plants. For each species, the recommended status according to the Natural Land Institute's Endangered Species Project is given: recommended for state endangered status (E), recommended for state threatened status (T), or being considered for federal listing (*). The numbers of significant features (SF's) and exceptional features (EF's) recognized by the Inventory are also given.

Scientific name	Common name	Status	SF	EF
Adoxa moschatellina	Moschatel	E	-	-
Aesculus discolor	Red buckeye	-	-	2
Agropyron subsecundum	Wheat grass	E	1	-
Aletris farinosa	Colic root	-	-	9
Alnus rugosa	Speckled alder	E	2	-
Amelanchier humilis	Low shadbush	-	-	2
Amelanchier interior	Shadbush	E	2	1
Ammophila breviligulata	Beach grass	E	1	-
Amorpha nitens	Indigo	E	1	-
Apios priceana	Price's potato bean	E*	1	-
Aralia hispida	Bristly sarsaparilla	E	-	1
Arctostaphylos uva-ursi	Bear-berry	E	4	-
Arenaria patula	Slender sandwort	T	-	-
Aristida desmantha	Three-awn grass	-	-	1
Aristida necopina	Three-awn grass	E	-	-
Aristolochia serpentaria var. *hastata*	Narrow-leaved snakeroot	E	2	-
Aristolochia tomentosa	Dutchman's pipevine	-	-	2
Aronia melanocarpa	Black chokeberry	-	-	17
Aronia prunifolia	Purple chokeberry	-	-	7
Artemisia dracunculus	False tarragon	T	3	-
Asclepias lanuginosa	Woolly milkweed	E	3	1
Asclepias meadii	Mead's milkweed	E*	2	-
Asclepias ovalifolia	Oval-leaved milkweed	E	-	-
Asclepias stenophylla	Narrow-leaved green milkweed	T	-	2
Asplenium bradleyi	Bradley's spleenwort	T	-	4
Asplenium resiliens	Black spleenwort	T	-	2
Aster furcatus	Forked aster	-	-	5
Aster schreberi	Schreber's aster	T	-	2
Aster undulatus	Aster	T	-	-
Astragalus tennesseensis	Milk vetch	E*	1	-
Bacopa acuminata	Water hyssop	E	-	-
Baptisia tinctoria	Yellow wild indigo	E	-	-
Bartonia paniculata	Screw-stem	E	2	-
Bartonia virginica	Yellow bartonia	-	-	7
Beckmannia syzigachne	American slough grass	E	-	-
Berberis canadensis	American barberry	E	2	-
Berchemia scandens	Supple-jack	E	1	-

Table 13. Rare, threatened, and endangered vascular plants, *continued.*

Scientific name	Common name	Status	SF	EF
Berula pusilla	Water parsnip	-	-	5
Betula lutea	Yellow birch	E	5	-
Betula papyrifera	Paper birch	-	-	6
Betula populifolia	Gray birch	E	1	-
Betula pumila	Dwarf birch	-	-	15
Betula sandbergii	Sandberg's birch	-	-	4
Bidens beckii	Water marigold	E	-	-
Boltonia asteroides var. *decurrens*	False aster	-*	-	2
Botrychium biternatum	Grape fern	E	1	-
Botrychium matricariaefolium	Grape fern	E	1	-
Botrychium multifidum	Northern grape fern	T	-	4
Botrychium simplex	Grape fern	E	2	-
Bouteloua gracilis	Blue grama	-	-	1
Buchnera americana	Blue hearts	-	-	7
Bumelia lanuginosa	Woolly buckthorn	E	5	-
Cacalia suaveolens	Sweet Indian plantain	-	-	2
Cakile edentula	Sea rocket	T	2	-
Calla palustris	Water arum	E	1	-
Calopogon tuberosus	Grass pink	T	-	10
Camassia angusta	Wild hyacinth	E	1	-
Cardamine pratensis var. *palustris*	Cuckoo flower	E	4	-
Carex abdita	Sedge	-	1	-
Carex alata	Winged sedge	E	1	-
Carex atherodes	Sedge	E	-	-
Carex aurea	Golden sedge	E	-	-
Carex austrina	Sedge	E	1	-
Carex communis	Sedge	E	-	-
Carex crawei	Sedge	E	1	-
Carex cumulata	Sedge	E	-	-
Carex decomposita	Sedge	E	3	-
Carex diandra	Sedge	-	-	1
Carex disperma	Sedge	E	2	-
Carex garberi	Sedge	E	-	-
Carex gigantea	Sedge	E	1	-
Carex intumescens	Swollen sedge	E	-	-
Carex laevivaginata	Sedge	-	-	1
Carex laxiculmis	Sedge	E	-	-
Carex nigro-marginata	Sedge	E	1	-
Carex oligosperma	Sedge	E	2	-
Carex oxylepis	Sedge	E	1	-

Table 13. Rare, threatened, and endangered vascular plants, *continued.*

Scientific name	Common name	Status	SF	EF
Carex pallescens	Sedge	E	-	-
Carex physorhyncha	Sedge	E	3	-
Carex plantaginea	Plantain-leaved sedge	E	1	-
Carex prasina	Sedge	E	1	-
Carex reniformis	Sedge	E	1	-
Carex richardsonii	Sedge	-	1	-
Carex rostrata	Sedge	E	-	-
Carex socialis	Sedge	-*	-	2
Carex striatula	Sedge	E	-	-
Carex styloflexa	Sedge	E	1	-
Carex tonsa	Sedge	E	1	-
Carex trisperma	Sedge	E	3	-
Carex viridula	Sedge	E	3	-
Carex woodii	Sedge	E	-	-
Carya aquatica	Water hickory	-	-	4
Carya pallida	Pale hickory	E	1	-
Castanea dentata	American chestnut	E	-	-
Castilleja sessiliflora	Downy yellow painted cup	E	7	-
Ceanothus ovatus	Red-root	E	3	-
Chamaedaphne calyculata	Leatherleaf	T	-	7
Chamaelirium luteum	Fairy wand	-	-	3
Chamaesyce polygonifolia	Seaside spurge	E	2	-
Chimaphila maculata	Spotted wintergreen	E	2	-
Chimaphila umbellata	Pipsissewa	E	-	1
Cimicifuga racemosa	Black cohosh	E	1	1
Cimicifuga rubifolia	Black cohosh	-*	-	3
Cinna latifolia	Drooping wood reed	E	-	-
Circaea alpina	Small enchanter's nightshade	E	1	-
Cirsium carolinianum	Carolina thistle	E	3	-
Cladium mariscoides	Twig rush	T	-	6
Cladrastis lutea	Yellow-wood	E*	1	-
Clematis crispa	Blue jasmine	E	1	-
Clematis viorna	Leatherflower	E	1	-
Comptonia peregrina	Sweet-fern	E	4	-
Conioselinum chinense	Hemlock parsley	E	1	-
Corallorhiza maculata	Spotted coralroot orchid	T	-	3
Corispermum hyssopifolium	Common bugseed	-	2	-
Cornus canadensis	Bunchberry	E	5	1
Corydalis aurea	Golden corydalis	E	-	-
Corydalis halei	Corydalis	E	-	-

Table 13. Rare, threatened, and endangered vascular plants, *continued*.

Scientific name	Common name	Status	SF	EF
Corydalis sempervirens	Pink corydalis	E	1	-
Cyperus lancastriensis	Galingale	E	3	-
Cypripedium acaule	Pink lady's slipper	E	2	-
Cypripedium X *andrewsii*	Lady's slipper	-	1	-
Cypripedium calceolus var. *parviflorum*	Small lady's slipper	E	2	-
Cypripedium candidum	White lady's slipper	E*	-	14
Cypripedium reginae	Showy lady's slipper	E	3	-
Daucus pusillus	Small wild carrot	E	-	-
Delphinium carolinianum	Wild blue larkspur	-	-	3
Dennstaedtia punctilobula	Hay-scented fern	T	-	6
Deschampsia cespitosa	Tufted hairgrass	-	-	8
Dioclea multiflora	Dioclea	E	1	-
Dirca palustris	Leatherwood	-	-	1
Dodecatheon amethystinum	Jeweled shooting star	E	2	1
Dodecatheon frenchii	French's shooting star	-*	-	8
Draba cuneifolia	Whitlow grass	E	1	-
Drosera intermedia	Narrow-leaved sundew	T	1	8
Drosera rotundifolia	Round-leaved sundew	E	4	-
Dryopteris celsa	Log fern	E	1	-
Dulichium arundinaceum	Three-way sedge	-	-	5
Echinodorus tenellus	Small burhead	E	2	-
Eleocharis equisetoides	Horsetail spike rush	E	1	-
Eleocharis olivacea	Spike rush	E	1	-
Eleocharis parvula	Dwarf spike rush	E	2	-
Eleocharis pauciflora	Spike rush	E	-	-
Eleocharis rostellata	Beaked spike rush	T	6	-
Epilobium strictum	Downy willow herb	T	-	6
Equisetum palustre	Marsh horsetail	E	-	-
Equisetum pratense	Meadow horsetail	E	2	-
Equisetum trachyodon	Horsetail	-	-	1
Eriophorum angustifolum	Narrow-leaved cotton grass	-	-	3
Eriophorum virginicum	Rusty cotton grass	E	3	1
Eriophorum viridi-carinatum	Tall cotton grass	E	1	-
Eryngium prostratum	Eryngo	E	2	-
Euonymus americanus	Strawberry-bush	T	-	3
Eupatorium incarnatum	Thoroughwort	E	2	-
Euphorbia spathulata	Spurge	E	-	-
Filipendula rubra	Queen-of-the-prairie	T	-	2
Fimbristylis baldwiniana	Sedge	E	2	-
Fibristylis vahlii	Sedge	E	1	-

Table 13. Rare, threatened, and endangered vascular plants, *continued*.

Scientific name	Common name	Status	SF	EF
Fuirena scirpoides	Umbrella sedge	E	-	-
Galium labradoricum	Bog bedstraw	T	-	8
Galium trifidum	Small bedstraw	-	-	8
Galium virgatum	Dwarf bedstraw	E	1	-
Gaultheria procumbens	Wintergreen	E	-	-
Gaylussacia baccata	Black huckleberry	-	-	13
Geranium bicknellii	Northern cranesbill	E	-	-
Gerardia pedicularia	False foxglove	-	-	12
Geum rivale	Purple avens	E	-	-
Glyceria arkansana	Manna grass	E	1	-
Glyceria borealis	Northern manna grass	E	1	-
Glyceria canadensis	Rattlesnake manna grass	E	-	-
Gnaphalium macounii	Western cudweed	E	-	-
Gymnocarpium dryopteris	Oak fern	E	3	-
Gymnopogon ambiguus	Beargrass	E	1	-
Habenaria cilaris	Yellow fringed orchid	E	1	-
Habenaria clavellata	Wood orchid	E	4	-
Habenaria flava var. *flava*	Tubercled orchid	E*	2	1
Habenaria flava var. *herbiola*	Tubercled orchid	T*	-	4
Habenaria hookeri	Hooker's orchid	E	-	-
Habenaria hyperborea	Green orchid	-	-	9
Habenaria leucophaea	White fringed orchid	E*	6	-
Habenaria peramoena	Purple fringeless orchid	-*	-	7
Habenaria psycodes	Purple fringed orchid	E	4	-
Habenaria viridis var. *bracteata*	Bracted orchid	-	-	3
Hackelia americana	Stickseed	E	1	2
Halesia carolina	Silverbell	E	5	-
Helianthus angustifolius	Narrow-leaved sunflower	T	-	3
Helianthus giganteus	Tall sunflower	E	1	-
Heliotropium tenellum	Slender heliotrope	E	1	-
Hepatica americana	Round-lobed hepatica	-	-	1
Heteranthera reniformis	Mud plantain	E	2	-
Hexalectris spicata	Crested coralroot orchid	E	5	-
Hibiscus palustris	Swamp rose mallow	-	2	-
Hottonia inflata	Water featherfoil	-	7	-
Hudsonia tomentosa	Beach heath	E	2	-
Hydrastis canadensis	Goldenseal	T*	-	9
Hydrocotyle ranunculoides	Water pennywort	E	1	-
Hydrolea uniflora	Hydrolea	E	1	-
Hymenopappus scabiosaeus	Hymenopappus	-	-	2
Hymenoxys acaulis var. *glabra*	Lakeside daisy	E	1	-
Hypericum adpressum	Creeping St. John's wort	E	1	-
Hypericum boreale	Northern St. John's wort	E	-	-

Table 13. Rare, threatened, and endangered vascular plants, *continued*.

Scientific name	Common name	Status	GF	EF
Hypericum canadense	Canadian St. John's wort	-	-	4
Hypericum densiflorum	St. John's wort	E	1	-
Hypericum kalmianum	Kalm's St. John's wort	E	5	-
Hypericum pyramidatum	Great St. John's wort	-	-	2
Iliamna remota	Kankakee mallow	E*	1	-
Iresine rhizomatosa	Bloodleaf	E	2	-
Iris fulva	Swamp red iris	T	-	3
Isotria medeoloides	Small whorled pogonia	E*	1	-
Isotria verticillata	Whorled pogonia	E	1	-
Juncus alpinus	Rush	E	2	-
Juncus vaseyi	Vasey's rush	E	-	1
Juniperus communis	Common juniper	T	-	6
Juniperus horizontalis	Trailing juniper	E	2	-
Justicia ovata	Water willow	E	-	-
Lactuca hirsuta	Wild lettuce	E	-	-
Lactuca ludoviciana	Prairie lettuce	E	-	-
Larix laricina	Tamarack	T	-	6
Lathyrus maritimus	Beach pea	E	1	-
Lathyrus ochroleucus	Pale vetchling	T	3	-
Lechea intermedia	Pinweed	E	2	-
Leptochloa panicoides	Salt meadow grass	E	-	-
Lespedeza leptostachya	Prairie bush-clover	E*	3	-
Lesquerella ludoviciana	Silvery bladder pod	E	1	-
Lilium superbum	Superb lily	E	3	-
Limnosciadium digitatum	Limnosciadium	E	1	-
Lipocarpha maculata	Sedge	E	-	-
Lonicera dioica	Red honeysuckle	-	-	2
Lonicera flava	Yellow honeysuckle	T	-	6
Luzula acuminata	Wood rush	E	-	-
Lycopodium clavatum	Running pine	E	2	-
Lycopodium dendroideum	Ground pine	E	1	-
Lycopodium inundatum	Bog clubmoss	E	-	-
Lycopodium lucidulum	Shining clubmoss	-	-	1
Lycopus amplectens	Sessile water horehound	E	-	-
Lysimachia fraseri	Loosestrife	E	2	-
Lysimachia radicans	Creeping loosestrife	E	2	-
Malus angustifolia	Narrow-leaved crab apple	E	-	-
Malvastrum angustum	Globe mallow	-	1	-
Matelea decipiens	Climbing milkweed	E	1	-
Matelea obliqua	Climbing milkweed	T	-	4
Medeola virginiana	Indian cucumber root	E	1	-
Melampyrum lineare	Cow-wheat	E	-	-
Melanthera nivea	Melanthera	E	2	-

Table 13. Rare, threatened, and endangered vascular plants, *continued.*

Scientific name	Common name	Status	SF	EF
Melothria pendula	Creeping cucumber	E	2	-
Mentzelia oligosperma	Stickleaf	-	-	5
Menyanthes trifoliata	Buckbean	-	-	9
Microseris cuspidata	Prairie dandelion	E	4	-
Mimulus glabratus	Yellow monkey flower	E	3	-
Monotropa hypopithys	Pinesap	-	-	2
Muhlenbergia capillaris	Hair grass	-	2	1
Muhlenbergia cuspidata	Prairie satin grass	-	-	4
Oenothera perennis	Small sundrops	E	2	-
Onosmodium molle	Marbleseed	E*	-	-
Opuntia fragilis	Prickly pear	-	-	1
Orobanche fasciculata	Clustered broomrape	E	3	1
Orobanche ludoviciana	Broomrape	E	2	-
Oryzopsis racemosa	Rice grass	T	-	9
Oxalis grandis	Large wood sorrel	E	4	-
Panax quinquefolius	Ginseng	T*	-	13
Panicum boreale	Northern panic grass	E	-	-
Panicum columbianum	Panic grass	E	-	-
Panicum hians	Panic grass	E	1	-
Panicum joori	Panic grass	E	1	-
Panicum longifolium	Panic grass	E	-	-
Panicum mattamuskeetense	Panic grass	E	1	-
Panicum nitidum	Panic grass	E	2	-
Panicum ravenelii	Ravenel's panic grass	E	1	-
Panicum stipitatum	Panic grass	E	1	-
Panicum yadkinense	Panic grass	E	1	-
Paspalum bushii	Bead grass	E	1	-
Paspalum dissectum	Bead grass	E	-	-
Paspalum lentiferum	Bead grass	E	1	-
Penstemon arkansanus	Beard-tongue	-	1	-
Penstemon grandiflorus	Large-flowered beard-tongue	E	3	-
Petalostemum foliosum	Leafy prairie clover	E*	4	-
Phacelia gilioides	Phacelia	E	-	-
Philadelphus pubescens	Mock orange	E	1	-
Phlox carolina subsp. *angusta*	Phlox	E	-	-
Phlox pilosa subsp. *sangamonensis*	Phlox	E	-	-
Physostegia intermedia	False dragonhead	E	-	-
Pinus banksiana	Jack pine	E	1	-
Pinus echinata	Shortleaf pine	E	3	-
Pinus resinosa	Red pine	E	1	-

Table 13. Rare, threatened, and endangered vascular plants, *continued.*

Scientific name	Common name	Status	SF	EF
Pinus strobus	White pine	-	-	6
Planera aquatica	Water elm	T	5	-
Plantago cordata	Heart-leaved plantain	E*	-	3
Plantago heterophylla	Small plantain	E	-	-
Poa alsodes	Woodland bluegrass	E	3	-
Poa autumnalis	Bluegrass	E	1	-
Poa languida	Woodland bluegrass	E	1	-
Poa wolfii	Meadow bluegrass	E	-	-
Pogonia ophioglossoides	Snake-mouth orchid	E	3	-
Polanisia jamesii	Clammy weed	T	-	3
Polygala incarnata	Pink milkwort	E	4	-
Polygonatum pubescens	Small Solomon's seal	E	-	1
Polygonum arifolium	Tear thumb	E	1	-
Polygonum careyi	Carey's smartweed	E	-	-
Polygonum longistylum	Smartweed	E	1	-
Polypremum procumbens	Polypremum	-	1	-
Populus balsamifera	Balsam poplar	E	4	-
Potamogeton friesii	Pondweed	-	-	1
Potamogeton gramineus	Pondweed	E	-	-
Potamogeton praelongus	Pondweed	E	-	-
Potamogeton pulcher	Pondweed	E	-	-
Potamogeton robbinsii	Pondweed	E	-	1
Potamogeton strictifolius	Pondweed	E	-	-
Potamogeton vaseyi	Pondweed	E	-	-
Potentilla anserina	Silverweed	-	-	2
Potentilla fruticosa	Shrubby cinquefoil	-	-	9
Potentilla millegrana	Cinquefoil	E	-	-
Potentilla palustris	Marsh cinquefoil	-	-	12
Primula mistassinica	Bird's-eye primrose	E*	1	-
Prunus pumila	Sand cherry	-	-	5
Ptilimnium costatum	Mock bishop's weed	E	-	3
Ptilimnium nuttallii	Mock bishop's weed	E	-	-
Puccinellia pallida	Alkali grass	E	-	-
Pycnanthemum albescens	White mountain mint	E	1	-
Pycnanthemum torrei	Mountain mint	E	1	-
Pyrola americana	Wild lily-of-the-valley	E	-	-
Pyrola secunda	One-sided shinleaf	E	-	1
Quercus nuttallii	Nuttall's oak	E	2	-
Quercus phellos	Willow oak	T	-	4
Quercus prinus	Rock chestnut oak	T	-	2

Table 13. Rare, threatened, and endangered vascular plants, *continued.*

Scientific name	Common name	Status	SF	EF
Ranunculus ambigens	Spearwort	E	-	-
Ranunculus cymbalaria	Seaside crowfoot	E	-	-
Ranunculus harveyi	Harvey's buttercup	-	-	3
Ranunculus rhomboideus	Prairie buttercup	T	-	2
Rhamnus alnifolia	Alder buckthorn	E	1	1
Rhexia mariana	Meadow beauty	-	-	1
Rhododendron prinophyllum	Pink azalea	-	-	4
Rhus vernix	Poison sumac	-	-	8
Rhynchospora alba	White beak-rush	T	6	1
Rhynchospora capillacea	Hair beak-rush	-	-	1
Rhynchospora globularis	Small beak-rush	E	-	-
Rhynchospora glomerata	Beak-rush	E	1	-
Rhynchospora macrostachya	Beak-rush	E	-	-
Ribes hirtellum	Northern gooseberry	E	1	-
Rorippa islandica subsp. *hispida*	Marsh cress	E	-	1
Rorippa truncata	Yellow cress	E	-	-
Rubus enslenii	Dewberry	E	1	-
Rubus odoratus	Purple flowering raspberry	E	2	-
Rubus pubescens	Dwarf raspberry	E	-	-
Rubus setosus	Bristly blackberry	E	-	1
Rudbeckia fulgida	Orange coneflower	-	-	9
Rudbeckia missouriensis	Missouri coneflower	E	5	-
Rumex hastatulus	Sour dock	E	-	-
Sabatia campestris	Prairie rose gentian	E	-	-
Sagittaria longirostra	Arrowhead	E	1	-
Salix candida	Hoary willow	-	-	17
Salix lucida	Shining willow	-	-	4
Salix pedicellaris	Bog willow	-	-	12
Salix serissima	Autumn willow	E	2	-
Salix syrticola	Dune willow	E	1	-
Salvia azurea subsp. *pitcheri*	Blue sage	T	-	3
Sambucus pubens	Red-berried elder	T	-	3
Sanguisorba canadensis	American burnet	E	1	-
Sarracenia purpurea	Pitcher plant	E	7	1
Saxifraga forbesii	Forbes' saxifrage	-*	-	3
Saxifraga virginiensis	Early saxifrage	E	3	-
Scheuchzeria palustris	Arrow-grass	E	1	-
Schizachne purpurascens	False melic grass	E	-	-
Scirpus cespitosus	Bulrush	E	3	-
Scirpus hallii	Bulrush	E	1	-
Scirpus hattorianus	Bulrush	E	-	-
Scirpus koilolepis	Bulrush	-	1	-
Scirpus microcarpus	Bulrush	E	-	-

Table 13. Rare, threatened, and endangered vascular plants, *continued.*

Scientific name	Common name	Status	SF	EF
Scirpus paludosus	Alkali bulrush	E	1	-
Scirpus pedicellatus	Bulrush	E	-	-
Scirpus polyphyllus	Leafy bulrush	T	-	4
Scirpus purshianus	Weak bulrush	E	1	-
Scirpus smithii	Bulrush	E	-	-
Scirpus torreyi	Bulrush	E	-	-
Scirpus verecundus	Bulrush	E	1	-
Scleria reticularis	Netted nut rush	E	-	-
Scleria verticillata	Low nut rush	-	-	8
Sedum telephioides	American orpine	-	-	4
Sesbania exaltata	Sesbania	-	1	-
Shepherdia canadensis	Canadian buffalo-berry	E	3	-
Silene regia	Royal catchfly	E	-	-
Sisyrinchium atlanticum	Blue-eyed grass	E	2	-
Sisyrinchium montanum	Mountain blue-eyed grass	E	-	-
Smilax herbacea	Carrion flower	-	1	-
Solidago arguta	Goldenrod	E	1	-
Solidago remota	Goldenrod	E	1	-
Solidago sciaphila	Cliff goldenrod	T	-	3
Sorbus americana	Mountain ash	E	1	-
Sparganium americanum	Bur-reed	E	1	-
Sparganium chlorocarpum	Green-fruited bur-reed	E	-	-
Sphaeralcea angusta	Globe mallow	E	-	-
Spiraea tomentosa	Hardhack	-	-	8
Spiranthes lucida	Early ladies' tresses	E	1	-
Spiranthes romanzoffiana	Hooded ladies' tresses	E	1	-
Spiranthes vernalis	Ladies' tresses	E	2	-
Stachys clingmanii	Hedge-nettle	E	1	-
Stellaria pubera	Great chickweed	E	1	-
Stenanthium gramineum	Grass-leaved lily	T	-	-
Stylisma pickeringii	Patterson's bindweed	T	4	-
Styrax americana	Storax	T	-	6
Styrax grandifolia	Big-leaf snowbell bush	E	1	-
Sullivantia renifolia	Sullivantia	T*	5	-
Synandra hispidula	Synandra	E*	4	-
Talinum calycinum	Large flower-of-an-hour	E	1	-
Talinum parviflorum	Small flower-of-an-hour	-	-	8
Talinum rugospermum	Flameflower	-	-	4
Thalia dealbata	Thalia	E	1	-
Thelypteris noveboracensis	New York fern	E	1	-
Thelypteris phegopteris	Long beech fern	E	2	-
Thismia americana	Thismia	E*	-	-
Thuja occidentalis	Arbor vitae	T	-	9

Table 13. Rare, threatened, and endangered vascular plants, *continued.*

Scientific name	Common name	Status	SF	EF
Tilia heterophylla	White basswood	E	3	-
Tofieldia glutinosa	False asphodel	T	7	-
Tradescantia bracteata	Prairie spiderwort	E	-	-
Triadenum virginicum	Pink St. John's wort	E	-	-
Trichomanes boschianum	Filmy fern	-	-	6
Trientalis borealis	Star-flower	T	-	5
Trifolium reflexum	Buffalo clover	E	1	-
Triglochin maritima	Arrow-grass	E	7	-
Triglochin palustris	Arrow-grass	E	4	-
Trillium cernuum	Nodding trillium	E	-	-
Trillium cuneatum	Trillum	E	-	-
Trillium erectum	Purple trillium	E	-	1
Trillium viride	Green trillium	T	-	-
Ulmus thomasi	Rock elm	E	2	-
Urtica chamaedryoides	Nettle	E	1	-
Utricularia cornuta	Horned bladderwort	E	1	-
Utricularia intermedia	Flat-leaved bladderwort	E	3	-
Utricularia minor	Small bladderwort	E	-	-
Vaccinium angustifolium	Early low blueberry	-	-	13
Vaccinium corymbosum	High-bush blueberry	E	4	-
Vaccinium macrocarpon	American cranberry	E	5	-
Vaccinium myrtilloides	Canada blueberry	-	-	2
Vaccinium stamineum	Deerberry	E	1	-
Valeriana uliginosa	Valerian	E	1	-
Valerianella intermedia	Corn salad	E	-	-
Valerianella umbilicata	Corn salad	E	-	-
Veratrum woodii	False hellebore	T*	-	2
Veronica americana	American brooklime	E	-	-
Veronica scutellata	Marsh speedwell	T	-	-
Viburnum molle	Arrowwood	E	2	-
Viola canadensis	White violet	E	1	-
Viola conspersa	Dog violet	T	-	1
Viola incognita	White violet	E	1	-
Viola pallens	Smooth white violet	-	-	6
Viola primulifolia	Primrose violet	E	2	-
Viola pubescens	Downy yellow violet	-	-	1
Viola viarum	Violet	E	-	-
Waldsteinia fragarioides	Barren strawberry	E	1	-
Woodsia ilvensis	Rusty woodsia	E	3	-
Woodwardia areolata	Netted chain fern	-	-	1

Table 13. Rare, threatened, and endangered vascular plants, *continued*.

Scientific name	Common name	Status	SF	EF
Woodwardia virginica	Chain fern	E	-	-
Xyris torta	Twisted yellow-eyed grass	-	-	8
Zigadenus glaucus	White camass	E	1	-
Zizania aquatica	Wild rice	-	-	2

Appendix 4.
PHYSIOGRAPHIC UNITS

The Inventory classified natural areas according to the *Physiographic Divisions of Illinois*. The classification consists of divisions, provinces, and sections, outlined by Fenneman (1928). The subdivisions of sections are by Leighton, et al. (1948). All the units are individually continuous, with no outliers or inliers, and a particular natural area was placed in only one physiographic unit. The physiographic unit was determined for 939 natural areas.

Table 14 presents the physiographic unit classification and gives the percentage of natural areas in each physiographic unit. Because the classification is a hierarchy of successively smaller subdivisions of Illinois, the percentages are given only for the finest subdivisions. For example, 12% of the areas are in the Wheaton Morainal Country and 2% are in the Chicago Lake Plain: consequently, 14% are in the Great Lakes Section, although this figure is not in the table.

Table 14. Physiographic units.

Unit	Percent of all natural areas
Interior Plains Division	
Central Lowland Province	
Wisconsin Driftless Section	2
Great Lakes Section	
Wheaton Morainal Country	12
Chicago Lake Plain	2
Till Plains Section	
Rock River Hill Country	8
Green River Lowland	1
Galesburg Plain	8
Kankakee Plain	5
Bloomington Ridged Plain	13
Springfield Plain	13
Mt. Vernon Hill Country	6
Dissected Till Plains Section	1
Interior Low Plateaus Province	
Shawnee Hills Section	14
Interior Highlands Division	
Ozark Plateaus Province	
Lincoln Hills Section	4
Salem Plateau Section	6
Atlantic Plain Division	
Coastal Plains Province	
East Gulf Coastal Plain Section	4
Mississippi Alluvial Plain Section	0.1

Appendix 5.
MAJOR TOPOGRAPHIC FEATURES

Dr. H. B. Willman of the Illinois State Geological Survey developed a classification of major topographic features specially for the Natural Areas Inventory. The major topographic features are large geographic areas, but they are smaller than the physiographic units described in Appendix 4. A physiographic unit has several major topographic features, and occasionally one natural area may have more than one major topographic feature. Table 15 outlines the classification of major topographic features and gives the number of times each term was used to describe a site. (The major topographic feature was determined for 937 natural areas.) The figures in the *frequency* column give the number of times each term was actually used, not the number of times each term could have been used. The classification is a hierarchy, and the more general terms were used only when a finer subdivision was undesirable or unattainable. For example, 46 areas were described as a flat till plain (with thick, medium, or thin loess), but one additional area was simply described as a flat till plain without regard to the loess thickness.

The classification describes the topographic situation of an area in broad terms (plains, hill country, lowlands, etc.) subdivided by genetic differences (till plains, dunic plains, sinkhole plains, etc.), and it includes the thickness of the loess. Because some areas identified by the Inventory are very small, it was necessary to include the larger individual features of valleys (bottomland, terrace, and valley wall) in the classification. This made it possible, for instance, to describe a hill prairie as being on a valley wall, which is more informative than classifying it as part of a dissected till plain. The major subdivisions are defined as follows:

Uplands.--Surfaces above and between major valleys; generally the highest surface in a region.

Lowlands.--Surfaces below the uplands and above the alluvial plains of the major rivers; in effect, extensive terraces.

Valleys.--Floodplains, terraces, and valley walls and slopes of major rivers, and directly related areas dissected by tributary ravines.

The terms for till plains are defined as follows:

Flat till plain.--Less than 5% valleys, hills, or ridges.

Ridged till plain.--Less than 5% valleys, with 5 to 50% hills and ridges; intended for moraines and ground moraines.

Slightly dissected till plain.--Between 5 and 10% valleys or ravines.

Moderately dissected till plain.--Between 10 and 30% valleys.

Strongly dissected till plain.--Between 30 and 75% valleys.

Areas with more than 75% dissected till plain are termed *hill country.* Loess thickness is defined with three ranges, which divide the state into three approximately equal areas:

Thick.--Greater than 12 feet.

Medium.--Between 4 and 12 feet.

Thin.--Less than 4 feet.

Table 15. Major topographic features.

Frequency	Feature
0	Uplands
0	Plains
1	Flat till plain
1	Flat till plain (thick loess)
20	Flat till plain (medium loess)
25	Flat till plain (thin loess)
0	Ridged till plain
0	Ridged till plain (thick loess)
5	Ridged till plain (medium loess)
11	Ridged till plain (thin loess)
0	Slightly dissected till plain
3	Slightly dissected till plain (thick loess)
19	Slightly dissected till plain (medium loess)
6	Slightly dissected till plain (thin loess)
0	Moderately dissected till plain
4	Moderately dissected till plain (thick loess)
21	Moderately dissected till plain (medium loess)
13	Moderately dissected till plain (thin loess)
0	Strongly dissected till plain
23	Strongly dissected till plain (thick loess)
50	Strongly dissected till plain (medium loess)
29	Strongly dissected till plain (thin loess)
4	Erosional plain
2	Erosional plain (thick loess)
3	Erosional plain (medium loess)
4	Erosional plain (thin loess)
0	Sinkhole plain
11	Sinkhole plain (thick loess)
1	Sinkhole plain (medium loess)
0	Sinkhole plain (thin loess)
0	Upland dunic plain
5	Upland dunic plain (thick loess)
0	Upland dunic plain (medium loess)
0	Upland dunic plain (thin loess)
0	Upland outwash plain
1	Upland outwash plain (thick loess)
0	Upland outwash plain (medium loess)
9	Upland outwash plain (thin loess)
0	Hill country
0	Glacial hills
1	Glacial hills (thick loess)
9	Glacial hills (medium loess)
51	Glacial hills (thin loess)
3	Eolian hills
4	Eolian hills (thick loess)
0	Eolian hills (medium loess)

Table 15. Major topographic features, *continued.*

Frequency	Feature
4	Eolian hills (thin loess)
6	Erosional hills in bedrock
81	Erosional hills in bedrock (thick loess)
93	Erosional hills in bedrock (medium loess)
4	Erosional hills in bedrock (thin loess)
0	Erosional hills in glacial drift
10	Erosional hills in glacial drift (thick loess)
20	Erosional hills in glacial drift (medium loess)
8	Erosional hills in glacial drift (thin loess)
0	Erosional hills in nonglacial, unconsolidated materials
7	Erosional hills in nonglacial, unconsolidated materials (thick loess)
4	Erosional hills in nonglacial, unconsolidated materials (medium loess)
3	Erosional hills in nonglacial, unconsolidated materials (thin loess)
0	Lowlands
0	Lowland till plain
0	Lowland till plain (thick loess)
0	Lowland till plain (medium loess)
0	Lowland till plain (thin loess)
34	Lake plain
1	Lake plain (thick loess)
6	Lake plain (medium loess)
36	Lake plain (thin loess)
1	Lowland dunic plain
0	Lowland dunic plain (thick loess)
2	Lowland dunic plain (medium loess)
14	Lowland dunic plain (thin loess)
0	Lowland outwash plain
0	Lowland outwash plain (thick loess)
3	Lowland outwash plain (medium loess)
4	Lowland outwash plain (thin loess)
2	Valleys
181	Bottomland
25	Terrace
0	Terrace (thick loess)
8	Terrace (medium loess)
28	Terrace (thin loess)
30	Valley wall
85	Valley wall (thick loess)
35	Valley wall (medium loess)
30	Valley wall (thin loess)

Appendix 6.
INDIVIDUAL TOPOGRAPHIC FEATURES

Dr. H. B. Willman devised a classification of individual topographic features to accompany the major topographic features in Appendix 5. The individual features (Table 16) are classified according to origin, with a few general terms (such as *depression* and *hill*) for features that could be classified separately under several different origins. The classification attempts to provide the most information possible about an area with only a few terms. The definitions follow general usage in Illinois.

Definitions of Terms

H. B. Willman

General features

Bluff.--High, steep slope or cliff.

Cliff.--Nearly vertical slope, generally in consolidated rocks, but in places sustained by a hard caprock overlying softer rocks.

Depression.--Area completely surrounded by higher land.

Escarpment.--Line of cliffs, generally developed in one rock unit and extending a long distance, even though interrupted by valleys.

Hill.--Slope not as steep as a cliff; an isolated elevation or a segment of a valley wall.

Knob.--Steep-sloped, isolated, more or less conical hill.

Mound.--Isolated hill, gentle to steep-sloped and conical to elongate.

Plain.--Relatively flat area which may be part of an upland, lowland, or former lake bottom.

Ridge.--Elongated hill.

Terrace.--Bench above the floodplain and below the upland; generally a segment of a former level of erosion or deposition in a valley.

Depositional features

Running water

Alluvial fan.--Fan-shaped deposit made by a creek where it discharges from a valley and loses velocity as it spreads onto

Table 16. Individual topographic features.

Feature	Frequency
General features	
Cliff	85
Depression	50
Escarpment	25
Hill	46
Knob	21
Mound	2
Plain	85
Ridge	37
Terrace	45
Depositional features	
Running water	
Alluvial fan	8
Crevasse ridge	3
Esker	3
Floodplain	206
Kame	6
Kame terrace	0
Natural levee	4
Outwash plain	18
River bar	13
Valley train	34
Gravity	
Landslide	2
Slump	1
Talus	4
Colluvial	
Alluvial cone	1
Mudflow	0
Lacustrine	
Beach	8
Delta	1
Lake bar	9
Ring mound	1
Spit	2
Glacial	
Drumlin	0
End moraine	89
Ground moraine	140
Interlobate moraine	0
Kettle	5
Swale	3
Swell	2
Eolian	
Barchan	2
Dune	52
Paha	2
Erosional features	
Running water	
Badland	3
Canyon	18
Channel	4
Col	1
Crevasse valley	0
Diversion channel	4
Divide	0
Falls	1
Fault-line scarp	8
Gorge	0
Gulley	22
Hogback	4
Meander	5
Ravine	288
Scour surface	10
Slip-off slope	2
Valley	22
Valley wall	242
Weathering	
Natural arch	1
Natural bridge	1
Eolian	
Blowout	20
Glacial	
Ice-shove mound	3
Lacustrine	
Beach	1
Bluff	6
Solutional features	
Sinkhole	26

Depositional features, cont.

a floodplain, lake plain, or terrace; grades and intertongues with colluvial features--alluvial cones and mudflows--along the base of steep slopes.

Crevasse ridge.--Nearly straight ridge of gravel and sand deposited in a crevasse in a glacier; a type of esker.

Esker.--Ridge formed largely of gravel and sand deposited by meltwater in a channel on, in, or under a glacier.

Floodplain.--Area of bottomland in a valley generally subject to annual or more frequent flooding and underlain by slackwater deposits.

Kame.--Roughly conical hill formed largely by deposition of sand and gravel in nearly vertical tunnels in or at the margin of a glacier.

Kame terrace.--Complex of kames roughly forming a bench along the former margin of an ice sheet.

Natural levee.--Ridge on the edge of a floodplain bordering the river channel, resulting from deposition of relatively coarse material, mostly sand, when the river loses velocity as it overflows onto the floodplain.

Outwash plain.--Relatively flat surface underlain by gravel and sand deposited by meltwater flowing from the front of a glacier.

River bar.--Elongate, generally oval-shaped ridge, largely of sand deposited in the channel of a river or creek. Includes sand, gravel, and rubble bars.

Valley train.--Long, narrow body of outwash confined within a valley.

Gravity

Landslide.--General term for earth materials displaced by gravity; commonly used for rough-surfaced area consisting of broken and jumbled blocks of rock that have fallen and slid from the upper part of steep slopes and bluffs.

Slump.--Dislodged blocks or step-like segments of a steep slope that have moved slowly downhill by successive ruptures roughly parallel to the slope.

Talus.--Unsorted accumulation of rock fragments, generally lacking a soil cover, at the base of a cliff and resulting from intermittent dislodgement of the materials from the cliff by weathering and animal activities.

Colluvial

Alluvial cone.--Small, steep-sloped, roughly conical accumulation of poorly sorted colluvium at the mouth of a sharp gulley in a steep slope.

Depositional features, cont.

Mudflow.--Colluvium deposited by a slurry-like mixture of water and earth material flowing from steep to low slopes onto a flat area; generally with lower surface gradients and smoother surface than alluvial fans.

Lacustrine

Beach.--Linear, gently sloping surface smoothed by wave action along the shore of a lake; underlain by sand or pebbly sand.

Delta.--Gently sloping, roughly fan-shaped surface along the shore of a lake; formed by deposition of sediments at the mouth of a stream or river.

Lake bar.--Elongate, generally oval-shaped ridge, largely of sand deposited in a lake.

Ring mound.--Small circular ridge, possibly a remnant of a glacial pingo, a dome-shaped layer of frozen ground which upon melting had a temporary central lake surrounded by material that now remains in a ridge. Found in Illinois only in an area at and near DeKalb.

Spit.--Bar of sand and silt built by longshore currents from the shore of a lake across, or partly across, the mouth of a valley or any indentation in the shoreline.

Glacial

Drumlin.--Elongate, oval, steep-sided ridge of glacial drift, mostly till, oriented in the direction of ice movement, the steeper end facing the direction from which the glacier advanced.

End moraine.--Rough-surfaced ridge of glacial drift distinguished by more and steeper-sloped knobs and swales than on the bordering ground moraine.

Ground moraine.--Area of glacial drift with less surface relief than the bordering end moraine.

Interlobate moraine.--End moraine topography formed at the junction of two glacial lobes.

Kettle.--Steep-sided depression in glacial drift formed by melting of a block of ice surrounded by drift which is commonly sand and gravel.

Swale.--Broad, shallow depression in a till plain.

Swell.--Broad, low hill in a till plain.

Eolian

Barchan.--Crescent-shaped dune, the points of which are drawn out in the direction of wind movement.

Dune.--Hill or ridge of wind-blown sand, generally characterized by a relatively steep slope on the downwind, advancing side of the dune.

Depositional features, cont.

Paha.--Hill or ridge consisting largely of relatively coarse-grained, weakly bedded loess, but generally containing layers of wind-blown sand; generally oval and steep-sloped with the long axis parallel to the dominant wind direction.

Erosional features

Running water

Badland.--Area intricately dissected by steep-sloped gulleys.

Canyon.--Valley with nearly vertical walls and a narrow floor, generally not as wide as the walls are high.

Channel.--Generally smooth-surfaced depression with steep-sided margins occupied, or formerly occupied, by a river or creek.

Col.--Low area in a divide between two drainage lines; a small pass.

Crevasse valley.--Linear, nearly straight depression in a till plain formed by erosion of a stream flowing in a glacial crevasse.

Diversion channel.--Segment of a valley, generally steep-walled, resulting from diversion of a river, usually by a glacier but also by flooding across a divide.

Divide.--Crest of a ridge separating two drainage basins.

Falls.--Cliff in a river or creek where water descends vertically or nearly so.

Fault-line scarp.--Cliff resulting from a fault that places a hard formation adjacent to a soft formation, followed by erosion that removes more of the soft formation.

Gorge.--Steep-sided, narrow-bottomed segment of a valley, or a small narrow channel within a canyon.

Gulley.--Small ravine, generally steep-sided, narrow-bottomed, and short.

Hogback.--Asymmetrical ridge developed in dipping rocks, the steep face cutting across the bedding, and the gentle slope paralleling the bedding.

Meander.--River or creek channel in the form of a loop.

Ravine.--Steep-sloped, narrow-bottomed valley, less steeply walled than a canyon.

Scour surface.--Rough, irregularly channeled surface produced by torrential currents.

Slip-off slope.--Surface preserved in the inside of a meander as a result of progressive widening and deepening, and generally marked by parallel ridges of sand and gravel marking successive stages of growth of the meander.

Erosional features, cont.

Valley.--Elongate depression excavated principally by running water and bounded by the tops of the valley walls. Also used as a general term to include the entire area drained by a river or creek.

Valley wall.--The slope from the upland to the valley floor or bottomland.

Weathering

Natural arch.--Arch formed by weathering out a relatively soft area of rock face on a valley wall.

Natural bridge.--Isolated arch or ledge of rock bridging a stream and resulting from weathering and stream erosion of less resistant surrounding rocks.

Eolian

Blowout.--Depression in a sandy area caused by wind removing sand.

Glacial

Ice-shove mound.--Hill composed of bedrock dislodged by a glacier.

Lacustrine

Beach.--Linear, gently sloping surface produced by wave action along the shore of a lake.

Solutional features

Sinkhole.--Depression, generally steep-sided and conical, formed by collapse of the roof of a cave or by solution of limestone or dolomite; or, in areas of thick loess, by flowage of the loess into open joints in the bedrock.

Appendix 7.
GEOLOGIC FORMATIONS

Table 17 lists the geologic formations in Illinois, according to *Handbook of Illinois Stratigraphy* by Willman, et al. (1975), and gives the number of times each formation was recognized in a natural area.

Table 17. Geologic formations.

Formation	Frequency	Formation	Frequency
	Cambrian System		
Mt. Simon Sandstone	--	Franconia Formation	2
Eau Claire Formation	--	Potosi Dolomite	2
Galesville Sandstone	--	Eminence Formation	--
Ironton Sandstone	--	Jordan Sandstone	--
	Ordovician System		
Gunter Sandstone	--	Quimbys Mill Formation	4
Oneota Dolomite	1	Spechts Ferry Formation	2
New Richmond Sandstone	2	Kings Lake Formation	--
Shakopee Dolomite	2	Guttenberg Formation	5
Everton Dolomite	--	Dunleith Formation	15
St. Peter Sandstone	22	Wise Lake Formation	17
Dutchtown Limestone	--	Dubuque Formation	2
Joachim Dolomite	2	Cape Limestone	1
Glenwood Formation	3	Scales Shale	11
Pecatonica Formation	7	Fort Atkinson Limestone	3
Mifflin Formation	6	Brainard Shale	7
Grand Detour Formation	11	Neda Formation	1
Nachusa Formation	9	Girardeau Limestone	1
	Silurian System		
Wilhelmi Formation	2	Blanding Formation	3
Elwood Formation	1	Sweeney Formation	3
Kankakee Formation	7	Marcus Formation	3
Joliet Formation	12	Edgewood Formation	9
Sugar Run Formation	9	Sexton Creek Limestone	6
Racine Formation	8	St. Clair Limestone	2
Mosalem Formation	6	Moccasin Springs Formation	--
Tete des Morts Formation	2		

Table 17. Geologic formations, *continued*.

Formation	Frequency	Formation	Frequency
	Devonian System		
Bailey Limestone	6	Blocher Shale	2
Grassy Knob Chert	3	Sweetland Creek Shale	--
Backbone Limestone	3	Grassy Creek Shale	5
Clear Creek Chert	5	Wapsipinicon Limestone	1
Grand Tower Limestone	3	Cedar Valley Limestone	12
Lingle Formation	2	Saverton Shale	5
Alto Formation	1	Louisiana Limestone	3
Sylamore Sandstone	2		
	Mississippian System		
Glen Park Formation	3	Renault Limestone	13
Hannibal Shale	26	Yankeetown Sandstone	9
Chouteau Limestone	10	Downeys Bluff Limestone	8
Springville Shale	3	Bethel Sandstone	8
Borden Siltstone	--	Ridenhower Formation	4
Fort Payne Formation	3	Cypress Sandstone	6
McCraney Limestone	3	Beech Creek Limestone	3
Prospect Hill Siltstone	1	Fraileys Shale	8
Starrs Cave Limestone	--	Haney Limestone	11
Meppen Limestone	7	Hardinsburg Sandstone	11
Fern Glen Formation	5	Glen Dean Limestone	9
Burlington Limestone	37	Tar Springs Sandstone	6
Keokuk Limestone	12	Vienna Limestone	2
Warsaw Shale	13	Waltersburg Formation	2
Sonora Formation	3	Menard Limestone	4
Ullin Limestone	4	Palestine Sandstone	3
Salem Limestone	24	Clore Formation	5
St. Louis Limestone	37	Degonia Sandstone	6
Ste. Genevieve Limestone	15	Kinkaid Limestone	24
Aux Vases Sandstone	9	Grove Church Shale	1
	Pennsylvanian System		
Caseyville Formation	68	Modesto Formation	19
Abbott Formation	23	Bond Formation	15
Spoon Formation	20	Mattoon Formation	8
Carbondale Formation	27		
	Cretaceous System		
Tuscaloosa Formation	1	Owl Creek Formation	1
McNairy Formation	9	Baylis Formation	2

Table 17. Geologic formations, *continued*.

Formation	Frequency	Formation	Frequency
	Tertiary System		
Clayton Formation	1	Mounds Gravel	7
Porters Creek Formation	2	Grover Gravel	5
Wilcox Formation	3		
	Quaternary System		
Enion Formation	3	Henry Formation	97
Banner Formation	11	Wedron Formation	195
Glasford Formation	188	Morton Loess	2
Pearl Formation	3	Richland Loess	223
Petersburg Silt	1	Peoria Loess	474
Teneriffe Silt	1	Lake Michigan Formation	8
Loveland Silt	6	Cahokia Alluvium	231
Winnebago Formation	15	Parkland Sand	70
Roxana Silt	18	Grayslake Peat	46
Robein Silt	3	Lacon Formation	--
Peddicord Formation	--	Peyton Colluvium	12
Equality Formation	78		

Appendix 8.
SOIL ASSOCIATIONS

Soil associations were recorded for 827 natural areas, using the classification and map developed by Fehrenbacher, et al. (1967). The 26 soil associations are in Table 18, with the percentage of Illinois occupied by each association and the percentage of the 827 natural areas that have soils in each particular association. For example, Association A covers 13.2% of Illinois, and 2.4% of the natural areas have soils in Association A. The percentages for the *natural area* column total greater than 100, because many areas have more than one soil association.

Table 18. Soil associations.

Soil association	Percent of state	Percent of all natural areas
DARK-COLORED SOILS		
Developed primarily from loess		
A Joy--Tama--Muscatine--Ipava--Sable	13.2	2.4
B Sidell--Catlin--Flanagan--Drummer	7.2	1.5
C Wenona--Rutland--Streator	0.3	0.0
D Harrison--Herrick--Virden	2.7	0.1
E Oconee-Cowden--Piasa	1.9	0.4
F Hoyleton--Cisne--Huey	5.0	1.0
Developed primarily from glacial drift		
G Warsaw--Carmi--Rodman	0.6	1.6
H Ringwood--Griswold--Durand	0.4	1.2
I LaRose--Saybrook--Lisbon	2.5	1.0
J Elliott--Ashkum--Andres	3.7	1.8
K Swygert--Bryce--Clarence--Rowe	2.2	1.3
LIGHT-COLORED SOILS		
Developed primarily from loess		
L Seaton--Fayette--Stronghurst	5.8	9.2
M Birkbeck--Ward--Russell	2.4	4.5
N Clary--Clinton--Keomah	8.0	6.2
O Stookey--Alford--Muren	1.8	8.0
P Hosmer--Stoy--Weir	5.9	11.0
Q Ava--Bluford--Wynoose	8.3	3.6
R Grantsburg--Robbs--Wellston	1.2	4.8
Developed primarily from glacial drift		
S Fox--Homer--Casco	0.3	1.3
T McHenry--Lapeer--Pecatonica	0.6	1.2
U Strawn--Miami	0.2	0.8
V Morley--Blount--Beecher--Eylar	1.8	6.0
DARK AND LIGHT-COLORED SOILS		
Developed primarily from medium and fine-textured outwash		
W Littleton--Proctor--Plano--Camden--Hurst--Ginat	12.1	12.1
Developed primarily from sandy material		
X Hagener--Ridgeville--Bloomfield--Alvin	3.4	11.0
Developed primarily from medium-textured material on bedrock		
Y Channahon--Dodgeville--Dubuque--Derinda	1.5	3.6

Table 18. Soil associations, *continued.*

Soil Association	Percent of state	Percent of all natural areas
DARK AND LIGHT-COLORED SOILS, *cont.*		
Developed primarily from alluvium		
Z Lawson--Beaucoup--Darwin--Haymond--Belknap.	7.0	24.7

Appendix 9.
FOREST COVER TYPES

The forest cover type according to the Society of American Foresters (1967) classification was recorded for 996 plant communities. Table 19 lists the SAF cover types noted in natural areas, and gives the number of times each was found.

Table 19. Society of American Foresters' forest cover types.

SAF cover type		Frequency
14.	Northern pin oak	13
20.	White pine--northern red oak--white ash	1
26.	Sugar maple--basswood	30
27.	Sugar maple	21
37.	Northern white cedar	1
38.	Tamarack	4
39.	Black ash--American elm--red maple	17
40.	Post oak--black oak	141
41.	Scarlet oak	1
42.	Bur oak	20
44.	Chestnut oak	1
46.	Eastern redcedar	5
48.	Eastern redcedar--hardwood	20
50.	Black locust	6
52.	White oak--~~red oak--hickory~~ W. oak -- Northern red oak	249
53.	White oak	136
54.	Northern red oak--basswood--white oak	65
55.	Northern red oak	13
57.	Yellow poplar	3
59.	Yellow poplar--white oak--northern red oak	5
60.	Beech--sugar maple	20
61.	River birch--sycamore	5
62.	Silver maple--American elm	89
63.	Cottonwood	19
64.	Sassafras--persimmon	5
65.	Pin oak--sweetgum	33
76.	Shortleaf pine--oak	1
87.	Sweetgum--yellow poplar	2
91.	Swamp chestnut oak--cherrybark oak	13
92.	Sweetgum--Nuttall's oak--willow oak	1
93.	Sugarberry--American elm--green ash	3
94.	Sycamore--pecan--American elm	6
95.	Black willow	15
96.	Overcup oak--water hickory	1
101.	Baldcypress	9
102.	Baldcypress-water tupelo	16
103.	Water tupelo	3

Appendix 10.
STREAM SYSTEMS

Smith (1971) developed a classification of Illinois streams based on their fishes. The 33 stream systems recognized by Smith are listed in Table 20, with the percentage of the 1089 natural areas in each system.

Table 20. Stream systems.

Stream system	Percent of all natural areas
Galena River system	1
Apple River system	1
Plum River system	1
Rock River--Green River system	11
Edwards River system	1
Henderson Creek system	1
Bear Creek system	2
The Sny--Bay Creek system	3
Des Plaines River system	11
Fox River system	7
Little Vermilion (of the north) River system	0.2
Big Bureau Creek system	1
Kankakee River--Iroquois River system	4
Mazon Creek system	1
Vermilion (of the north) River system	2
Kickapoo Creek system	2
Spoon River system	1
La Moine River system	2
Mackinaw River system	3
Sangamon River system	4
Indian--Sandy--Apple--Macoupin--Otter Creek system	3
Wood River--Cahokia Creek system	2
Kaskaskia River--Marys River system	6
Big Muddy River system	6
Clear Creek--Horseshoe Lake system	2
Cache River system	6
Massac--Bay--Lusk--Big Grand Pierre--Big Creek system	7
Saline River system	2
Little Wabash River system	2
Bonpas Creek system	0.4
Embarras River system	3
Tributaries of Wabash River in Crawford, Clark, and Edgar cos.	1
Little Vermilion--Vermilion River system	2

Appendix 11.
USES OF NATURAL AREAS

Table 21 lists 19 use categories, with the percentage of all areas, and the percentage of Category I areas, in each of the categories.

Table 21. Uses of natural areas.

Use category	Percent of all natural areas	Percent of Cat. I areas
No apparent use	31	32
Low-intensity uses		
Low-intensity recreation (hiking, hunting, boating, etc.).	34	40
Research and education visits	23	17
Wildlife or fish management	3	3
Other low-intensity uses.	0.4	0.7
Resource exploitation and high-intensity uses		
Logging (within the past year).	3	2
Grazing (within the past year).	10	8
Mining (within the past year)	1	2
Intensive agriculture (rowcrops, hayfields, orchards, etc.)	7	7
High-intensity recreation (playgrounds, campgrounds, motorcycle trails, etc.) . .	4	5
Other high-intensity uses	0.3	0.2
Intrusions		
Improved roads.	10	8
Railroads	9	10
Artificial water impoundments	1	1
Buildings	7	7
Utility corridors (pipelines, powerlines, etc.)	3	5
Cemeteries.	3	5
Dumps	1	0.2
Other intrusions.	1	1

Appendix 12.
MANAGEMENT NEEDS

Table 22 summarizes (1) the kinds of major management needs identified in the natural areas, (2) the part of the natural area affected by the management problem, and (3) the effort needed to correct or contain the problem.

The management needs are listed in five categories: (1) Control of *human overuse and abuse* includes actions to stop or limit such activities as trampling, littering, vandalism, and theft of walnut trees. (2) Examples of *vegetation and animal management* include control of woody invasion of prairies, control of competing organisms that threaten to eliminate an endangered species, and control of exotic species. (3) *Incompatible uses* on the natural area or adjacent land include grazing and trash dumping. (4) Removal of *roads and buildings* is often necessary because they are nuisances that encourage uses incompatible with maintaining the natural area. (5) *Water levels* sometimes must be restored to natural levels; and *soil erosion*, usually started or accelerated by people, is often a problem.

The impact of the management problem is described according to the land condition class affected: (1) The *significant feature* is the part of the natural area that includes the feature that is the reason for identifying the natural area. (2) *Natural land* is any Grade A, B, or C land. (3) *Buffer land* is any Grade D or E land outside the significant feature.

Fieldworkers estimated the effort required to correct a problem or to continually maintain an area where the problem cannot be eliminated. An example of management work that may correct a problem with one effort is removal of an old, abandoned trash dump. A use that is incompatible with an area's natural features (such as a road) may require a strong measure (a barricade) and continual vigilance (repair of the barricade), if the use is a long-standing tradition. Many problems with vandalism or trampling by visitors may be uncontrollable if the area is left open to the public.

The following table summarizes information from 100 randomly selected natural areas, and the percentages probably are representative of all natural areas identified by the Inventory. Management problems were noted in 76 of the 100 areas, and a total of 126 problems were identified in these 76 areas. The percentages in the *impact* section total more than 100%, because some management problems affect more than one of the three land condition classes.

Table 22. Summary of major management needs.

Management problem	Percent of natural areas
Description	
Control of human overuse and abuse.	27
Vegetation and animal management.	27
Elimination of incompatible uses on area or adjacent land	23
Removal of roads, buildings, and other structures	15
Control of erosion or restoration of altered water levels	8
Impact	
Buffer land	16
Natural land (other than significant feature)	48
Significant feature	81
Effort	
Problem may be corrected relatively easily, with one effort	30
Problem may be controlled with continual management	55
Problem may be uncontrollable, even with a major effort or continual management	15

Appendix 13.
MANAGEMENT AGENCIES

Table 23 lists the number of natural areas that are known to be on land owned or managed by various groups. Inclusion in this table does not necessarily mean that an area is protected: 214 of the sites are owned by a public agency or a railroad company but are not managed as natural areas by these agencies. Natural areas are not tabulated if they are Category V areas and the only significant feature is the fact that a college or university maintains the site for its own teaching and research activities. Four hundred and thirty-two areas are considered in the tabulation, but the sum of the areas in the right column is greater than 432 because some tracts are owned or managed by more than one agency.

Table 23. Management agencies. Natural areas owned or managed by public agencies, colleges, universities, railroad companies, and private preservation organizations.

Owner or manager	Number of natural areas
U. S. Government	
U. S. Forest Service (Shawnee National Forest)	79
U. S. Fish & Wildlife Service (National Wildlife Refuges)	17
U. S. Army, Corps of Engineers	6
Joint Corps of Engineers and Fish & Wildlife Service	7
Other Federal agencies	5
State of Illinois	
Illinois Department of Conservation	100
Illinois Department of Transportation	22
Other State agencies, or agency unknown	7
Other public agencies	
Conservation Districts	21
Forest Preserve Districts	50
Park Districts	16
Soil & Water Conservation District	3
Sanitary Districts, Airport Authority	5
Colleges and universities (public and private)	21
Railroad companies	92
Private preservation organizations	
The Nature Conservancy	17
Other preservation organizations	15

Appendix 14.
OWNERSHIP, PRESERVATION STATUS, AND THREATS

Ownership

Types of ownership are categorized as pubiic, private, or unknown. An area may have any or all of the three ownership types. Information about ownership is presented in Tables 24, 25, and 30.

Preservation Status

The categories for preservation status are as follows:

Dedicated Illinois Nature Preserve
Public land, formally designated as a natural area
Public land, informally recognized as a natural area
Public land, not recognized as a natural area
Private land, protected by owner or lessee
Private land, not protected by owner or lessee
Preservation status unknown

An area could be in any number of the above seven categories. Tables 26, 27, and 31 summarize information about preservation status.

Threats

Threats to natural areas are categorized as follows:

Threat of destruction within 1 year
Threat of destruction known, but not immediate
Threat likely to develop within 5 years
No known threat, and none likely to develop within 5 years

An area could have any number of the above kinds of threats. Tables 28 through 32 summarize information about threats.

Table 24. Ownership type, according to natural area category.

Ownership	All areas (1089 areas)	Cat I (610 areas)	Cat II (269 areas)	Cat III (39 areas)	Cat IV (160 areas)	Cat V (251 areas)	Cat VI (29 areas)	Cat VII (17 areas)
Private	754 (69%)	477 (78%)	169 (63%)	24 (61%)	131 (81%)	84 (33%)	25 (86%)	15 (88%)
Public	411 (38%)	185 (30%)	139 (52%)	24 (61%)	35 (22%)	191 (76%)	9 (31%)	14 (82%)
Unknown	64 (6%)	30 (5%)	17 (6%)	1 (3%)	20 (12%)	7 (3%)	1 (3%)	--

Table 25. Ownership type for Category I areas, according to community class.

Ownership	All areas (610 areas)	Forest (171 areas)	Prairie (253 areas)	Savanna (35 areas)	Wetland (118 areas)	Lake & Pond (40 areas)	Primary (64 areas)	Cave (30 areas)
Private	477 (78%)	124 (72%)	205 (81%)	20 (57%)	84 (71%)	31 (78%)	55 (86%)	28 (93%)
Public	185 (30%)	73 (43%)	52 (21%)	15 (43%)	45 (38%)	14 (35%)	32 (50%)	10 (33%)
Unknown	30 (5%)	5 (3%)	15 (6%)	4 (11%)	7 (6%)	--	1 (2%)	--

Table 26. Preservation status, according to natural area category.

Preservation Status	All areas (1089 areas)	Cat. I (610 areas)	Cat. II (269 areas)	Cat. III (39 areas)	Cat. IV (160 areas)	Cat. V (251 areas)	Cat. VI (29 areas)	Cat. VII (17 areas)
Illinois Nature Preserve	66 (6%)	42 (7%)	39 (14%)	7 (18%)	5 (3%)	67 (27%)	1 (3%)	3 (18%)
Public, formal natural area	156 (14%)	46 (8%)	32 (12%)	7 (18%)	6 (4%)	131 (52%)	2 (7%)	--
Public, informal natural area	67 (6%)	49 (8%)	27 (10%)	3 (8%)	3 (2%)	18 (7%)	1 (3%)	2 (12%)
Public, not protected	160 (15%)	81 (13%)	64 (24%)	12 (31%)	25 (16%)	11 (4%)	4 (14%)	12 (70%)
Private, protected	124 (11%)	75 (12%)	19 (7%)	5 (13%)	4 (2%)	51 (20%)	2 (7%)	--
Private, not protected	566 (52%)	361 (59%)	135 (50%)	15 (38%)	121 (75%)	30 (12%)	23 (79%)	14 (82%)
Unknown	135 (12%)	75 (12%)	42 (16%)	8 (20%)	27 (17%)	12 (5%)	2 (7%)	1 (6%)

Table 27. Preservation status of Category I natural areas, according to community class.

Preservation Status	All Cat. I (610 areas)	Forest (171 areas)	Prairie (253 areas)	Savanna (35 areas)	Wetland (118 areas)	Lake & Pond (40 areas)	Primary (64 areas)	Cave (30 areas)
Illinois Nature Preserve	42 (7%)	17 (10%)	16 (6%)	4 (11%)	17 (14%)	7 (18%)	4 (6%)	--
Public, formal natural area	46 (8%)	19 (11%)	15 (6%)	3 (9%)	9 (8%)	5 (12%)	5 (8%)	3 (10%)
Public, informal natural area	49 (8%)	27 (16%)	13 (5%)	5 (14%)	16 (14%)	3 (7%)	5 (8%)	--
Public, not protected	81 (13%)	29 (17%)	19 (8%)	6 (17%)	16 (14%)	4 (10%)	24 (37%)	8 (27%)
Private, protected	75 (12%)	48 (28%)	16 (6%)	2 (6%)	11 (9%)	2 (5%)	3 (5%)	2 (6%)
Private, not protected	361 (59%)	61 (36%)	176 (70%)	17 (49%)	63 (53%)	23 (58%)	47 (73%)	26 (87%)
Unknown	75 (12%)	21 (12%)	26 (10%)	5 (14%)	21 (18%)	8 (20%)	7 (11%)	--

Table 28. Threat of destruction, according to natural area category.

Threat	All areas (1089 areas)		Cat. I (610 areas)		Cat. II (269 areas)		Cat. III (39 areas)		Cat. IV (160 areas)		Cat. V (251 areas)		Cat. VI (29 areas)		Cat. VII (17 areas)	
Immediate	69	(6%)	55	(9%)	32	(12%)	2	(5%)	5	(3%)	8	(3%)	6	(21%)	2	(12%)
Known, but not immediate	193	(18%	142	(23%)	64	(24%)	5	(13%)	4	(2%)	23	(9%)	8	(27%)	9	(53%)
Likely to develop within 5 years	284	(26%)	207	(34%)	94	(35%)	9	(23%)	12	(7%)	14	(6%)	16	(55%)	4	(23%)
None anticipated	586	(54%)	241	(40%)	105	(39%)	27	(69%)	142	(89%)	217	(86%)	2	(7%)	4	(23%)

Table 29. Threat of destruction of Category I natural areas, according to community class.

Threat	All Cat. I (610 areas)		Forest (171 areas)		Prairie (253 areas)		Savanna (35 areas)		Wetland (118 areas)		Lake & Pond (40 areas)		Primary (64 areas)		Cave (30 areas)	
Immediate	55	(9%)	15	(9%)	23	(9%)	9	(26%)	18	(15%)	9	(22%)	12	(19%)	4	(13%)
Known, but not immediate	142	(23%)	18	(11%)	92	(36%)	7	(20%)	27	(23%)	11	(28%)	8	(12%)	5	(17%)
Likely to develop within 5 years	207	(34%)	69	(40%)	70	(28%)	13	(37%)	35	(30%)	10	(25%)	27	(42%)	20	(67%)
None anticipated	241	(40%)	79	(46%)	87	(34%)	12	(34%)	50	(42%)	17	(42%)	26	(41%)	5	(17%)

Table 30. Threat of destruction, according to ownership type.

Threat	All areas (1089 areas)		Private (754 areas)		Public (411 areas)		Unknown (64 areas)	
Immediate	65	(6%)	57	(8%)	16	(4%)	5	(8%)
Known, but not immediate	190	(17%)	166	(22%)	38	(9%)	13	(20%)
Likely to develop within 5 years	282	(26%)	233	(31%)	84	(20%)	20	(31%)
None anticipated	586	(54%)	329	(44%)	287	(70%)	30	(47%)

Table 31. Threat of destruction, compared with preservation status.

Threat	Ill. Nature Preserve (66 areas)		Public, formal natural area (156 areas)		Public, informal natural area (67 areas)		Public, not protected (160 areas)		Private, protected (124 areas)		Private, not protected (566 areas)		Status unknown (135 areas)	
Immediate	3	(5%)	5	(3%)	5	(7%)	7	(4%)	2	(2%)	51	(9%)	10	(7%)
Known, but not immediate	11	(17%)	7	(4%)	8	(12%)	21	(13%)	21	(17%)	146	(26%)	18	(13%)
Likely to develop within 5 years	7	(11%)	12	(8%)	10	(15%)	62	(39%)	18	(15%)	188	(33%)	46	(34%)
None anticipated	53	(80%)	136	(87%)	51	(76%)	76	(48%)	83	(67%)	215	(38%)	65	(48%)

Table 32. Threats to significant features of natural areas.

Threats	All SF's	Cat.I	Cat.II	Cat.III	Cat.IV	Cat.V	Cat.VI	Cat.VII
Conversion of area to another use								
Construction of buildings	125	79	36	3	3	1	3	--
Mining	43	24	11	3	2	--	3	--
Cultivation	40	24	11	--	--	5	--	--
Drainage and dredging of wetlands	28	18	9	--	--	--	--	1
Clearing of vegetation	27	16	10	--	--	--	--	1
Navigation and flood control projects, other water impoundments	19	8	4	--	--	--	1	6
Construction of roads and rest stops	16	9	2	--	--	4	1	--
Recreational development	10	5	2	--	3	--	--	--
Planting of trees	5	3	2	--	--	--	--	--
Sale of land, with probable change of land use	29	26	2	--	--	--	1	--
Use of land, without major conversion to another use								
Logging	90	60	25	1	2	2	--	--
Maintenance of railroad rights-of-way	73	59	6	--	--	8	--	--
Grazing	58	45	13	--	--	--	--	--
Mowing and burials in cemeteries	15	14	1	--	--	--	--	--
Maintenance of road rights-of-way	11	2	9	--	--	--	--	--
Wildlife management	7	4	3	--	--	--	--	--
Other uses and abuses								
Vandalism, including removal of animals and plants	52	24	14	--	--	1	13	--
Trampling, over-visitation	35	12	19	1	--	2	--	1
Water pollution and siltation	32	14	8	--	--	1	7	2
Natural changes, usually started or accelerated by people								
Erosion	20	10	7	2	--	1	--	--
Invasion of prairies by woody plants	10	8	2	--	--	--	--	--
Other vegetation succession, and interspecific competition	12	2	10	--	--	--	--	--

Appendix 15.
WHY NATURAL AREAS EXIST

Tables 33 through 37 enumerate the reasons why there still are natural forests, prairies, savannas, barrens, wetlands, and habitats with endangered plants in Illinois.

The tables include educated guesses about some natural areas, but the overall totals probably are close to the actual situation. The fieldworkers sometimes chose not to ask the landowner why an area had been protected, for fear that this might endanger the area.

Only the most important reasons were tabulated for each area--rarely more than one principal reason, and sometimes one or two secondary reasons.

Table 33. Why natural forests exist. The number of areas is given for which each reason is the principal cause, or a secondary cause, of the forest's protection.

Reason	Principal	Secondary
Forest is not easily exploited.		
Dry, rocky soil with scrubby timber	8	1
Steep slope	1	2
Wet soil	--	1
Land isolated by a river or other barrier	--	4
Forest is not intentionally protected, but has survived because of land use.		
Hunting, fishing, or recreation area	9	1
Public land, not intensively used	1	--
Forest has been intentionally protected.		
Land protected by private individuals or families	54	--
Land in public ownership, on which the forest has been preserved or has recovered from disturbance	39	--
Land protected by private individuals or families, then acquired by a conservation or preservation agency	21	--
Forest apparently has been protected, for an unknown reason.	42	--

Table 34. Why natural prairies exist. The number of areas is given for which each reason is the principal cause, or a secondary cause, of the prairie's protection.

Reasons	Principal	Secondary
Prairie is not easily exploited.		
Hill prairie (steep, dry soil; poor access). . . .	86	2
Sandy, dry soil.	16	2
Sandy, wet soil.	13	6
Gravelly soil.	12	1
Wet soil (not sandy)	11	1
Thin soil over bedrock (wet or dry).	10	3
Land isolated in a wetland	2	--
Prairie is not intentionally protected, but has survived because of land use patterns.		
Railroad right-of-way.	62	--
Cemetery	17	--
Land subdivided or held by speculators	13	2
Odd tract of farmland, isolated from grazing, and not easily cultivated	7	10
Public land, not intensively used (Army arsenal, etc.)	6	1
Hunting area	2	--
Former livestock holding area in railroad yard.	1	--
Former part of fairgrounds	1	--
Idle land adjoining railroad, colonized in part by prairie from railroad right-of-way	--	4
Abandoned pasture.	--	2
Prairie has been intentionally protected or has been managed for the prairie.		
Land acquired by a conservation or preservation agency, on which prairie has been preserved or has recovered from disturbance	5	8
Land protected by private individuals or families.	5	2
Cemetery managed to restore the prairie.	--	13

Table 35. Why natural savannas and barrens exist. The number of areas is given for which each reason is the principal cause, or a secondary cause, of the savanna's or barren's protection.

Reason	Principal	Secondary
Savanna or barren is not easily exploited.		
Sandy, dry soil	15	3
Thin, dry soil on steep slopes or over bedrock	9	--
Land isolated in a wetland	1	--
Savanna or barren is not intentionally protected, but has survived because of land use.		
Cemetery	7	--
Land subdivided or held by speculators	2	--
Hunting area	1	1
Land has been intentionally preserved, or has been managed to protect the savanna or barren.		
Land acquired by a conservation or preservation agency, on which the savanna or barren has been preserved or has recovered from disturbance	2	4
Cemetery managed to restore the savanna or barren	--	1

Table 36. Why natural wetlands exist. The number of areas is given for which each reason is the principal cause, or a secondary cause, of the wetland's protection.

Reason	Principal	Secondary
Wetland is not easily exploited.		
Poorly drained or undrained land	111	4
Wetland is not intentionally protected, but has survived because of land use.		
Hunting or fishing area	4	8
Land subdivided or held by speculators	4	1
Public land, not intensively used	1	1
Multiple ownership which probably prevents drainage efforts	--	4
Wetland has been intentionally protected.		
Land in public ownership on which the wetland has been preserved or has recovered from disturbance	11	4
Land protected by private individuals or families	7	2
Land protected by private individuals or families, then acquired by a conservation or preservation agency	2	1

Table 37. Why habitats with endangered plants exist. For each reason, the number of significant feature occurrences is given.

Reason	Occurrences
Habitat is not easily exploited.	
Wet soil (sandy, peaty, alluvial, etc.)	172
Dry, sandy soil	59
Rocky soil (usually dry soil)	40
Cliff	29
Dry, exposed slope (hill prairies, narrow ridges)	22
Steep slope (bluffs, steep ravines)	17
Gravelly soil	10
Habitat persists because of the protection or use of the land.	
Land that has been intentionally preserved	62
Typical upland forest that has not been intentionally preserved, but has not been severely disturbed	31
Typical bottomland forest that has not been intentionally preserved, but has not been severely disturbed	6
Odd tract of land (cemetery, railroad right-of-way, etc.)	20
Land subdivided or held by speculators	5
Habitat is a disturbed or artificial area	31

Appendix 16.

DETERMINING BOUNDARIES OF NATURAL AREAS, SIGNIFICANT FEATURES, AND LAND CONDITION CLASSES

Natural Area Boundaries

Category I natural areas

The boundaries of a Category I natural area are determined by the boundaries of the natural land and buffer land as discussed below. Following are the general guidelines for determining natural area boundaries:

(1) *Natural area boundaries should follow the boundaries of natural features*, which may or may not coincide with artificial lines or boundaries. Examples of the boundaries of natural features include the edges of woods and the limits of watersheds. Artificial lines or boundaries include roads, fences, and property lines. The boundaries of a natural feature often coincide with artificial lines because of changes in land use along these lines. For instance, the edge of a forest may follow a property line because the forest on the opposite side of the property line has been cleared. If the edge of the natural land does not follow a straight artificial boundary such as a property line, the natural area boundary should not be extended to an artificial boundary unless the additional area is needed as buffer land.

(2) *Acquisition factors should not be considered when determining the boundaries of a natural area.* These practical factors include (1) ownership boundaries, (2) monetary value of the land, (3) availability of the land, (4) access, and (5) the need for adjacent land for other uses such as nature interpretation and maintenance facilities. These considerations are beyond the scope of the Natural Areas Inventory.

(3) *Natural area boundaries should be conservative.* The natural area should have the minimum area needed to (1) include the significant feature, (2) include enough additional natural land to adequately represent the diversity of the area, and (3) insure potential for

the area's protection and management. Unnecessary land should not be included because this often introduces more management problems, causes extra work during the final field survey, and may lead to questions about the validity of the boundaries. The significant feature is the most important part of a natural area; additional natural land should be included only to the extent that it complements and protects the significant feature. For example, if the significant feature is a band of old growth dry-mesic forest midslope on a forested bluff, the natural area boundaries should be extended vertically to include the dry blufftop and the mesic lower slope, but the boundaries should not extend laterally along the bluff far from the significant feature. If the significant feature occurs on one side of a deep, narrow ravine, then both sides of the ravine should be in the natural area; but if the significant feature is on the side of a broad valley, then the natural area should be limited to one side. Designation of buffer land should be similarly restricted. It may be argued that no area is safe from outside influences, even if the entire watershed is managed to preserve the area; however, buffer land should be restricted to the immediate area needed to protect the natural land from direct influences and to provide manageable boundaries. The need to include the natural diversity of an area must be tempered with the need to have a manageable area with defendable boundaries.

(4) *Natural area boundaries should not be drawn arbitrarily.* Three guidelines, listed in order of priority, should be used to determine boundaries: (1) Sharp changes in natural quality should be used as first choice. (2) If there is no sharp break (for example, if a Grade C forest extends a great distance from the significant feature), then watershed boundaries should be used as natural area boundaries. (3) Occasionally even watershed boundaries are unclear or unsuitable; in such a case, some other boundary may be used, provided that the reason for choosing the boundary is recorded as an additional note on the Main Data Form.

Other categories of natural areas

The guidelines also apply to natural areas other than Category I. However, the boundaries of other kinds of natural areas usually extend little if any beyond the significant feature boundaries, because in these cases, land is rarely added to the significant feature to add diversity. Category II and III natural areas are usually small, and the boundaries include only the habitat with the endangered or relict species, plus any land needed to protect that habitat. For natural areas that have only Category IV, V, VI, or VII significant features, the natural area boundary usually coincides with the significant feature boundary.

Boundaries of Significant Features

Category I significant features

A Category I significant feature is an area of land or water that is relatively undisturbed. Two points of view are useful for determining the presence or boundaries of a Category I significant feature in the field. First, ask, "If all the land is the same natural quality as the part I am viewing, will the tract qualify as a natural area?" If the answer is yes, then the land is part of the significant feature, provided that the acreage is large enough. Second, ask, "Could the land I am viewing qualify alone as a natural area if (a) all the natural land around it were cleared, but (b) sufficient buffer land were provided?" If the answer is yes, then the land is part of the significant feature, provided that the acreage is large enough.

Other categories of significant features

The boundaries for significant features other than Category I are drawn to include the feature that is the reason for recognizing the natural area. The boundaries of a Category II significant feature include the population of the endangered plant or the breeding site of the endangered animal. A Category III significant feature coincides with the habitat of the relict plants. The boundaries of a Category V significant feature are the same as the boundaries of the area specifically dedicated to natural studies or nature preservation. The boundaries of a Category IV, VI, or VII significant feature include the outstanding geologic feature,

unique natural feature, or aquatic feature. The significant feature's boundaries delimit only the most important part of a natural area, but additional land may be included in the natural area to provide a buffer to the significant feature.

Boundaries of Natural Land and Buffer Land

Natural land

After the significant feature is delimited, one must decide how much more natural land should be in the natural area boundaries. Two factors should be considered: sufficient natural land should be added to (1) represent the natural diversity of the area, and to (2) help protect the significant feature:

(1) For Category I natural areas, the focus is on the significant feature, but the boundaries should include adjacent land sufficient to make the natural area a true natural system, rather than a single feature. The full diversity of natural communities directly associated with the significant feature should be included within the Category I natural area boundaries. For other categories of natural areas, the boundaries should be more conservative.

(2) Natural land also serves to protect the significant feature, but including excessive natural land, far removed from the significant feature, can cause management problems. A Grade C natural community should not be included in the natural area boundaries if it (1) is distant from the significant feature, (2) does not serve to protect the significant feature, and (3) does not help provide manageable boundaries for the natural area. One must balance the importance of representing the natural diversity of the site against the need to avoid excessive land and more management problems.

Buffer land

Buffer land is disturbed land that would be excluded from the natural area, except for these reasons: (1) the need to identify land with uses or conditions damaging to the natural land, and (2) the need for manageable boundaries. These two reasons are explained below:

(1) If the current use or condition of land adjoining the natural land is damaging to the natural land, then the land must be included as buffer. For instance, if runoff from a garbage dump is damaging the natural land, then the dump must be included in the natural area as buffer because its use must be changed to protect the natural land. Or, if the pastured heads of ravines above a natural forest are eroding and causing siltation in the natural land, then the heads of the ravines must be included as buffer land. The adjoining land must have a use or condition that has a significant impact on the natural land in order to be designated buffer. To determine whether the impact is significant, one should decide whether continuance of the incompatible use or condition will change the natural quality of the natural land. If the land use or condition is not causing rapid changes and has been long-standing, but the natural land still qualifies for inclusion in a natural area, then one should seriously question whether the adjoining land should be designated as buffer land. Only the current use or condition of adjoining land should be considered when designating buffer land: changes in land use should not be anticipated. For example, a woodlot may be surrounded by cropland, and if it is not significantly affected by agricultural chemicals and unnatural runoff, then it does not require buffer land. One should not designate a strip of cropland surrounding the woodlot as buffer land simply because the construction of apartments (a change in land use) next to the forest would have a significant impact on the area.

(2) Natural land often surrounds or adjoins Grade D or E land that does not have current uses or conditions detrimental to the natural land, but which should be included as buffer land to provide manageable boundaries to the natural area. Three examples: (1) Grade E and D land (such as a cultivated or abandoned field) wholly within a complex of wetland and prairie should be included in the natural area to avoid an "inholding," but its disturbed quality should be recognized by designating it as buffer land. (2) A series of narrow, cleared ridgetops that extend into a Grade B forest should be included in the natural area boundaries as buffer land to give the

area manageable and defendable boundaries, even though the fields have no direct, damaging effect on the forest. (3) The natural area boundaries should be drawn around an entire woodlot, even though the edges and corners of the woodlot may be Grade D (regrowth). These regrowth stands may not be critical to the continued maintenance of the area as a natural area, but they should be included as buffer land to give the natural area sensible boundaries.

Appendix 17.
MAIN DATA FORM AND INSTRUCTIONS

Figure 5 is a Main Data Form, which is the form for recording standard information about natural areas. The instructions for the form have been modified slightly by deleting references to some instruction supplements and substituting references to sections and appendices of this technical report. The substitutions are italicized.

Instructions for Completing the Main Data Form

The numbered items correspond to numbers on the Main Data Form. Items that are marked with an asterisk or with a prime mark are not computerized.

Basic information

(1) *Index number*.--This number is assigned when the information is computerized.

(2) *County*.--Enter the name of the county. If the site is in more than one county, enter the name of the county that is combined with the reference number (item 3), and list the other county or counties in parentheses after the first county name.

(3) *Reference number*.--The reference number is a number or letter-number combination which distinguishes each site from other sites in the same county. The reference numbers need not be consecutive. If a reference number has not already been assigned, assign a reference number that has not been used in the county.

(4) *Natural area name*.--Enter the name of the area. If an area has more than one name, give the other name in parentheses after the primary name. The name published in a report or on a map is preferred unless another name is widely accepted and customarily used. If an area has no known name, suggest one based on the owner's name or a natural feature.

Significance

(5) *Natural area categories and significant features*

(a) *Category*.--List the category or categories to which the natural area is assigned. The categories, listed below, are described in detail in *Section 4*.

I. Ecological area
II. Endangered species habitat

ILLINOIS NATURAL AREAS INVENTORY
MAIN DATA FORM

BASIC INFORMATION

(1) Index no. ______

(2) County ____________________ (3) Ref. no. ______

(4) Natural area name ______________________________

SIGNIFICANCE

(5) Natural area categories and significant features

a. Cat	*Lgd	b. Description of significant feature

(6) Exceptional features and notable features

a. Cat	*Lgd	*E/N	b. Description of feature

(7) PV score ____ (8) Evaluator ____________________ (8') Date ____________

LOCATION

(9) Legal location: T. ______, R. ______, ____ P. M., sec. ____________

____

____

(9') Access: ______________________________

____

(10) Topographic quadrangle ______________________________

(11) Watershed ______ (12) Specific stream ____________________

(13) Legislative district ______ (14) Municipality ____________________

NATURAL CHARACTERISTICS

(15) Altitude: a. minimum ______ b. maximum ______

(16) Topography:

a. Physiographic unit ____ b. Major feature ____ c. Individual feature ________

(17) Geologic formation ______________________________

(18) Soil association (State) ________

(19) Soil association (County) ______________________________

____

Figure 5. Main Data Form.

ILLINOIS NATURAL AREAS INVENTORY--MAIN DATA FORM p. 2

NATURAL CHARACTERISTICS, cont.

(20) Natural community classification and (21) rarity index (RI)

NC#	a. Natural community name	b. ND-S	c. Community-type	RI

(22) Diversity index ____

(23) Natural quality: (a) acreage of natural communities by grades, and (b) description

NC#	A	B	C	D	E	Tot	Description of natural quality
TOT							(24) Total acreage of natural area

(25) Vegetation types

NC#	a. SAF	b. Plant community name

LEGAL STATUS & USE

(26) Ownership type: 1. Pv 2. Pc 3. Uk (27) Number of owners ____

(27') Owner or custodian: ______________________

____

Figure 5. Main Data Form, *continued.*

ILLINOIS NATURAL AREAS INVENTORY--MAIN DATA FORM p. 3

LEGAL STATUS & USE, cont.

(28) Use of natural area:

a. Cat ____________ b. Description ______________________________

(29) Use of surrounding land:

a. Wildland ____% b. Farmland ____% c. Developed land ____%

(30) Nearest SMSA ____ (31) Distance to nearest SMSA ____

(32) Number of nearby schools ____ (33) Nearest school ____

(34) Number of nearby DOC facilities ____ (35) Other land management facility ____

(36) Manageability: 1. Yes 2. No

(36') Management problem description

	Impact			Effort			
	1	2	3	1	2	3	4

(37) Preservation status

Cat	* %	*Description of preservation status

(37') Attitude of owner or custodian toward preservation (contacted?): ____________

____

(38) Threats

a. Cat	*SF	b. Description of threat

DISCUSSION OF PRESERVATION VALUES

(39) ______________________________

ADDITIONAL NOTES

(39') ______________________________

Figure 5. Main Data Form, *continued.*

ILLINOIS NATURAL AREAS INVENTORY--MAIN DATA FORM p. 4

SUPPLEMENTAL MATERIALS

(40) Species lists:

1. ___ Woody plants
2. ___ Ferns and fern allies
3. ___ Summer birds
4. ___ Amphibians, reptiles, and mammals
5. ___ Other species list

(41) Sampling forms:

1. ___ Tree basal area
2. ___ Tree density
3. ___ Sapling and shrub density
4. ___ Prairie frequency
5. ___ Other sampling form

(41') Other materials:

1. ___ Topographic map copy
2. ___ Site map ______________________
3. ___ Significant feature forms: I II III IV V VI VII
4. ___ Other materials ______________________________________

(42) Literature citations:

____

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*Items continued from preceding pages:

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Figure 5. Main Data Form, *continued*.

III. Relict species habitat
IV. Geologic area
V. Natural study area
VI. Unique natural area
VII. Aquatic area

(*) *Legend*.--Enter the lower-case letter corresponding to each significant feature that is on the site map.

(b) *Description of significant feature*.--List the significant feature that corresponds to each natural area category in the following manner:

I. Give the *grade* and the *natural community*. Examples:

Grade A marsh
Grade A and B dry-mesic upland forest
Grade A and B wet prairie, mesic prairie

II. Name the *endangered species*, and give its *habitat*. Example:

Indiana bat (Hibernaculum in abandoned limestone mine)

III. Name the *relict species*, and give the *habitat*. Example:

Pinus strobus and *Taxus canadensis* (North-facing sandstone cliff)

IV. Name the *geologic feature*. Example:

Outstanding exposure of Nebraskan outwash

V. Name the institution managing or using the area for teaching or research; or give the status of the area. Examples:

Western Illinois University natural area
Federal Research Natural Area

VI. Name the *unique natural feature*. Example:

Outstanding invertebrate cave fauna

VII. Name the *aquatic feature*. Example:

Outstanding example of the glacial lakes and ponds of northern Illinois

(6) *Exceptional features and notable features*

(a) *Category*.--List the category of the exceptional or notable feature, equivalent to the category of the significant feature (*Table 2*).

(*) *Legend*.--Enter the lower-case letter that was assigned to each exceptional or notable feature that is on the site map.

(*) *Exceptional/Notable*.--For each entry, note whether the feature is exceptional (E) or notable (N).

(b) *Description of feature.*--Describe each feature with the format for significant features shown in item 5b.

(7) *Preservation value score.*--Record the site's value relative to other natural areas on a scale of 1 to 5 (low to high). The Department of Conservation specified that this estimate should be based on the evaluator's best judgement, without formal guidelines.

(8) *Evaluator.*--Enter the name of the person who determined the preservation value score and the name of other people who conducted the final field survey.

(8') *Date.*--Enter the date when the final field survey was completed, or (for sites that were not field-checked) when the preservation value score was determined.

(9) *Legal location.*--Give the location by Township, Range, Principal Meridian, section, and quarter-quarter section. Note the quarter-quarter section that includes the center of the area.

(9') *Access.*--If permission is required to visit the site, give as complete information as possible (name, address, and phone number of owner or custodian). Give directions to the area if the best access is not obvious from reading a county highway map or a topographic map. For example, describe places suitable for parking a vehicle or crossing a stream if this is important.

(10) *Topographic quadrangle.*--Name the USGS topographic quadrangle or quadrangles that cover the area. Include the series (7.5' or 15') in the name. List 7.5' maps instead of 15' maps if available. Give the index number of each quadrangle in parentheses after the quadrangle name.

(11) *Watershed* (changed to *stream system*).--Enter the number corresponding to the stream system, according to the Illinois Natural History Survey classification (*Appendix 10*).

(12) *Specific stream.*--Enter the name of the smallest stream that is named on the topographic map and that drains the entire natural area.

(13) *Legislative district.*--Give the number of the legislative district that includes the natural area.

(14) *Municipality.*--If the site is inside an incorporated area, enter the name of the municipality.

Natural characteristics

(15) *Altitude*

(a) *Minimum.*--Give the minimum altitude of the site, to the nearest contour interval on the topographic map.

(b) *Maximum.*--Give the maximum altitude as described in item 15a.

(16) *Topography*

(a) *Physiographic unit.*--Enter the number corresponding to the physiographic unit (*Appendix 4*).

(b) *Major feature.*--For each physiographic unit, enter the number corresponding to the major feature or features (*Appendix 5*).

(c) *Individual feature.*--Enter the number corresponding to any special or distinctive individual feature (*Appendix 6*).

(17) *Geologic formation.*--Enter the number corresponding to the geologic formation or formations in the natural area (*Appendix 7*).

(18) *Soil association (State classification).*--Enter the name (a single letter) of the dominant soil association, according to the classification on the "General Soil Map of Illinois" (*Appendix 8*).

(19) *Soil association (County classification).*--Enter the name of the dominant soil association according to the classification on the county general soil map or similar map.

(20) *Natural community classification (Appendix 30)*

(*) *Natural community number.*--Number each natural community in sequence, corresponding to numbers on the overlays with the site map.

(a) *Natural community name.*--Enter the name of the natural community.

(b) *Natural Division and Section.*--For each natural community, enter the number and letter of the Natural Division and Section.

(c) *Community-type* (changed to *community class*).--For each natural community, enter the number and the name of the corresponding community class, according to the following list:

1. Forest
2. Prairie
3. Savanna
4. Wetland
5. Lake and Pond
6. Stream
7. Primary
8. Cave
9. Cultural

(21) *Rarity index.*--Estimate the abundance of each natural community relative to its presettlement extent on a scale of 1 (abundant) to 5 (very rare).

(22) *Diversity index.*--Count and enter the number of natural communities that have Grade A, B, or C examples in the natural area.

(23) *Natural quality*

(*) *Natural community number.*--Number the communities as in item 20.

(a) *Acreage of natural communities by grades.*--Enter the acreage of each grade for each community, or a "P" for "present," whichever is applicable. (See *Section 7* for a discussion of mapping and measuring acreages and grades.) Enter only one acreage figure on a line, so that there will be space to describe the

natural quality on the same line in item 23b.

Total the acreage for each community (across), and for each grade (down).

(b) *Description of natural quality.*--For each grade in each community, briefly describe the natural quality, stressing disturbances or indicators of disturbance. Examples:

For a Grade A glade:	Essentially undisturbed
For a Grade B prairie:	Conservative plants absent
For a Grade C forest:	Mature second growth
For a Grade D forest:	Regrowth

(24) *Total acreage of natural area.*--If acreages of all communities were recorded, sum totals from the bottom line of this section for the grand total acreage. Cross-check the total acreage by summing the far-right column. For a natural area in which not all of the acreages in item 23 were measured and recorded, measure and enter the total acreage independent of natural community acreages.

(25) *Vegetation types*

(*) *Natural community number.*--Enter the same numbers as in item 20 for each natural community.

(a) *SAF cover type.*--If appropriate, enter the number of the Society of American Foresters' Forest Cover Type for each plant community (*Appendix 9*).

(b) *Plant community name.*--For each natural community, enter the name of the plant community or communities, if appropriate. Use scientific names. Do not abbreviate scientific names. Naming plant communities is discussed in *Appendix 28*.

Legal status and use

(26) *Ownership type.*--Circle the appropriate numbers: (1) private, (2) public, or (3) unknown. A natural area may have any or all ownership types. For example, if a natural area is mostly a public park, but the type of ownership of part of the site is unknown, then both "2" and "3" would be circled.

(27) *Number of owners.*--Give the number of ownerships (not the number of ownership types). If there are five or more owners, enter "5+" for "five or more."

(27') *Owner or custodian.*--If known, give the name, address, phone number, or other pertinent information about the owner or custodian.

(28) *Use of natural area*

(a) *Category.*--List uses of the natural area according to the categories in *Appendix 11*.

(b) *Description of use.*--If an "other" use (category 2.3, 3.6, or 4.5) is listed, mark the category with an asterisk and briefly describe the use on the line provided.

(29) *Use of surrounding land.*--Estimate use, to the nearest 10%, of land within 1 mile of the boundaries of the natural area, in the following broad categories:

(a) *Wildland* (forest, natural aquatic areas, abandoned farmland)

(b) *Farmland* (cropland, pastureland, orchards, farmsteads)

(c) *Developed land* (towns, factories, quarries, reservoirs)

(30) *Nearest SMSA.*--Give the number corresponding to the nearest SMSA (Standard Metropolitan Statistical Area). If the natural area is inside an SMSA, name this SMSA.

(31) *Distance to the nearest SMSA.*--Give the straight-line distance, to the nearest mile, from the center of the natural area to the nearest boundary of the SMSA. If the natural area is inside an SMSA, enter "0" for the distance.

(32) *Number of nearby schools.*--Count the number of colleges and universities within 40 miles of the center of the natural area. If there are 10 or more colleges or universities within 40 miles, enter "10+" for "10 or more."

(33) *Nearest school.*--Name the nearest university within 40 miles. If there is no university within 40 miles, name the nearest college instead.

(34) *Number of nearby DOC facilities.*--Count the number of Department of Conservation land management facilities within 25 miles of the center of the natural area.

(35) *Other land management facility.*--If a natural area falls within the jurisdiction of an agency other than the Department of Conservation which could manage or does manage the site, enter the number corresponding to the name of the agency on the master list of agencies.

(36) *Manageability.*--Circle "1" for "Yes" or "2" for "No" to state whether an area is ecologically manageable. An area is ecologically manageable unless "4" under "Effort" in item 36' is marked.

(36') *Management problem description.*--Describe each management problem (*Appendix 12*).

Describe the problem according to the location of its *impact*:

1. Buffer land
2. Natural land (other than significant feature)
3. Significant feature

Describe the anticipated *effort* which would be required to correct the management problem or for continual maintenance:

1. Problem can be corrected relatively easily, with one initial effort.
2. Problem may be controlled with continual management.
3. Problem may be uncorrectable, even with a major initial effort or continual management.
4. Natural area is not manageable with ecological techniques.

(37) *Preservation status*

Category.--Note the preservation status of the area, using the following categories. An area may have more than one preservation status category.

1. Dedicated Illinois Nature Preserve
2. Public land, formally designated as a natural area
3. Public land, informally recognized as a natural area
4. Public land, not recognized as a natural area
5. Private land, protected by owner or lessee
6. Private land, not protected by owner or lessee
7. Preservation status unknown

(*) *Percentage.*--If parts of the area have different preservation statuses, give the approximate percentage in each status.

(*) *Description of preservation status.*--If necessary for a clear understanding of the area's preservation status, explain the reasoning for the designation.

(37') *Attitude of owner or custodian toward preservation.*--State whether the owner or manager was contacted. If known, describe the attitude of the owner or manager toward protection. Note whether the person might be receptive to dedicating the area as a Nature Preserve. Note whether the owner or manager is indifferent, or against the idea of preserving the area.

(38) *Threats*

(a) *Category.*--Note any threat of destruction of the area according to the following categories. An area may have more than one threat category if it is large, and parts have different statuses.

1. Threat of destruction within 1 year
2. Threat of destruction known, but not immediate
3. No known threat, but a likelihood that a threat will develop within 5 years
4. No known threat, and no likelihood that a threat will develop within 5 years

(*) *Significant feature.*--If the threat would damage the significant feature, mark this column.

(b) *Description of threat.*--If the threat is category 1, 2, or 3, describe the threat.

Discussion of preservation values

(39) Summarize the preservation values of the natural area in a sentence or short paragraph.

Additional notes

(39') Explain how the natural area boundaries were determined if the reasoning would not be apparent to another person reading the site map. In most cases, there is no need to explain. If the boundaries follow sharp breaks in natural quality or follow watershed boundaries, there is no need to explain. If the boundaries are seemingly arbitrary, then explain.

If the reason for including a tract of buffer land would not be clear to another person, explain.

If the basis for naming the natural area is not apparent, explain.

Record other pertinent information that has not been entered elsewhere.

Supplemental materials

(40) *Species lists.*--Check the species lists that were completed.

(41) *Sampling forms.*--Check the sampling forms that were completed.

(41') *Other materials.*--Check the other materials that are in the natural area's file. Describe the kind of site map: if it is an ASCS aerial photo copy, give the year of the photo (e.g., "ASCS 1971"). If line 4 is checked, explain what kind of other materials are in the file.

(42) *Literature citations.*--Cite publications and studies about the natural area which are not in the natural area's file.

(*) *Items continued from preceding pages.*--Use these lines to continue any items that could not be completed in the preceding pages.

Appendix 18.
EXAMPLES OF NATURAL AREA DATA

Figure 6 includes a computer printout and a topographic map for a natural area. The printout is complete, with all possible items printed, but the computer can also produce shorter printouts of any combination of items for each natural area.

Most of the summaries in this report were produced by the Inventory's computer. Figure 7 is a section from a printout of a special statistical program that produced many of the acreage summaries for this report. Numbers in the column on the left are code numbers for natural communities, and the other numbers are acreage figures for the various natural quality grades.

ILLINOIS NATURAL AREAS INVENTORY

AREA # 375

COUNTY: Alexander

REFERENCE NUMBER: 12

AREA NAME: Horseshoe Lake Nature Preserve

NATURAL AREA CATEGORIES & SIGNIFICANT FEATURES:

CAT.	DESCRIPTION
V	National Natural Landmark
V	Illinois Nature Preserve
I	Grades A & B Swamp
I	Grades A & B Wet floodplain forest, Mesic floodplain forest
II	Quercus nuttallii (Wet bottomland forest)
II	Eupatorium incarnatum (Wet bottomland forest)

EXCEPTIONAL FEATURES:

CAT.	DESCRIPTION
II	Quercus phellos (Wet bottomland forest)
II	Mole salamander (Wet bottomland forest and swamp)
II	Bald eagle (Vicinity is wintering site and potential breeding site)
II	Swainson's warbler (Wet bottomland forest)
II	Brown creeper (High potential for nesting in forest)
II	Purple gallinule (Lake has high potential for nesting)
II	Green treefrog (Breeds on area)
II	Bird-voiced treefrog (Wet forest and swamp)
II	Mud snake (May occur in bottomland forest)

PRESERVATION VALUE SCORE: 5

EVALUATOR: Hutchison

LEGAL LOCATION:
SEQ SEC 9, SWQ SEC 10, WH SEC 15, EH SEC 16, T16S R2W 3PM

TOPOGRAPHIC QUADRANGLE: Tamms 7.5
Cache 7.5

STREAM SYSTEM: Cache River system

LEGISLATIVE DISTRICT: 59

MUNICIPALITY: None

MINIMUM ALTITUDE: 325

MAXIMUM ALTITUDE: 340

PHYSIOGRAPHIC UNIT: East Gulf Coastal Plain Section

MAJOR TOPOGRAPHIC FEATURE:
Bottomland

INDIVIDUAL TOPOGRAPHIC FEATURE:
Floodplain

GEOLOGIC FORMATION:
Cahokia Alluvium

SOIL ASSOCIATION:
W Littleton-Proctor-Plano-Camden-Hurst-Ginat

NATURAL DIVISION AND SECTION:
Bottomlands Section, Coastal Plain Division

NATURAL COMMUNITY
Wet floodplain forest

NATURAL DIVISION AND SECTION: 14b

Figure 6. Example of a computer printout and topographic map for a natural area.

AREA # 375 PAGE 2

COMMUNITY CLASS: Forest

RARITY INDEX: Very rare

NATURAL QUALITY:

56 acres of Grade A
Essentially undisturbed
27 acres of Grade B
Old second growth
27 acres of Grade C
Mature second growth

SAF COVER TYPE: Swamp chestnut oak--cherrybark oak
Cottonwood

PLANT COMMUNITY:
Quercus michauxii--Quercus rubra--Liquidambar styraciflua
swamp chestnut oak--red oak--sweetgum
Populus deltoides
cottonwood

NATURAL COMMUNITY
Swamp

NATURAL DIVISION AND SECTION: 14b

COMMUNITY CLASS: Aquatic

RARITY INDEX: Very rare

NATURAL QUALITY:

17 acres of Grade A
Essentially undisturbed
49 acres of Grade C
Mature swamp forest in Horseshoe Lake

SAF COVER TYPE: Bald cypress--water tupelo

PLANT COMMUNITY:
Taxodium distichum--Nyssa aquatica
bald cypress--tupelo

NATURAL COMMUNITY
Mesic floodplain forest

NATURAL DIVISION AND SECTION: 14b

COMMUNITY CLASS: Forest

RARITY INDEX: Very rare

NATURAL QUALITY:

26 acres of Grade A
Essentially undisturbed
27 acres of Grade B
Old second growh
37 acres of Grade C
Mature second growth

SAF COVER TYPE: Beech--sugar maple
Northern red oak--basswood--white ash
Pin oak--sweetgum

PLANT COMMUNITY:
Fagus grandifolia--Quercus michauxii--Acer saccharum

Figure 6. Example of a computer printout and topographic map for a natural area, *continued*.

AREA # 375 PAGE 3

beech--swamp chestnut oak--sugar maple
Quercus rubra--Carya spp.--Ulmus americana
red oak--hickories--American elm
Liquidambar styraciflua--Liriodendron tulipifera--Quercus spp.
sweetgum--tuliptree--oaks
Vitis spp.
grapes

NATURAL COMMUNITY
Cropland

NATURAL DIVISION AND SECTION: 14b

COMMUNITY CLASS: Cultural

RARITY INDEX: Not applicable

NATURAL QUALITY:

26 acres of Grade E
Cultivated field

SAF COVER TYPE: Not collected

PLANT COMMUNITY:
Not collected

DIVERSITY INDEX: 3

TOTAL ACREAGE: 292

OWNERSHIP TYPE: Public

NUMBER OF OWNERSHIPS: 1

USE OF NATURAL AREA:
No apparent use

USE OF SURROUNDING LAND (% wildland): 60

USE OF SURROUNDING LAND (% farmland): 40

USE OF SURROUNDING LAND (% developed land): 0

NEAREST SMSA: St. Louis (Madison and St. Clair counties)

DISTANCE TO NEAREST SMSA: 79

NUMBER OF NEARBY SCHOOLS: 1

NEAREST SCHOOL: Shawnee Community College, Karnak

NUMBER OF NEARBY DOC FACILITIES: 3

LAND MANAGEMENT FACILITY:
Illinois Department of Conservation

GOVERNOR'S REGION: 5

PLANNING COMMISSION: Southern Five Regional Planning and Development Comm.

FOREST PRESERVE DISTRICT: None

CONSERVATION DISTRICT: None

MANAGEABILITY: Yes

PRESERVATION STATUS:

Figure 6. Example of a computer printout and topographic map for a natural area, *continued*.

AREA # 375 Page 4

PRESERVATION STATUS:
Dedicated Illinois Nature Preserve

THREATS:
No known threat

SPECIES LISTS:
Woody plants
Ferns and fern allies
Summer birds
Amphibians, reptiles, and mammals

SAMPLING FORMS:
Tree basal area
Tree density
Sapling and shrub density

DISCUSSION OF PRESERVATION VALUES:

Horseshoe Lake Nature Preserve is a dedicated Illinois Nature Preserve and a Registered Natural Landmark at Horseshoe Lake Conservation Area. This 292-acre preserve includes high and very high quality bottomland forest and swamp communities. It provides habitat for two endangered plants, and the area is the known habitat for four rare or threatened vertebrates. There is high potential for the occurrence of four other rare or endangered vertebrates on the site.

PUBLICATIONS:
NOTE: The Inventory found 53 literature references to Horseshoe Lake. Only part of the citations are given in this example to conserve space.

Cavanaugh, J.A., G.T. Weaver, and P.A. Robertson. 1974. Distribution models for woody species in a southern Illinois bottomland forest. (Abstr.) Assoc. Southeastern Biol. Bull. 21:46

Coulter, S.M. 1903. An ecological comparison of some typical swamp areas. Rep. Missouri Bot. Garden 15:38-71

Elder, W.H. 1945. The spadefoot toad in Illinois. Copeia 1945:122.

Evers, R.A. and L.M. Page. 1977. Some unusual natural areas of Illinois. Ill. Natur. Hist. Surv. Biol. Notes 100. 47 p.

Ferry, J.F. 1907. Winter bird notes from extreme southern Illinois. Auk 24:281-286.

Gunning, G.E., and W.M. Lewis. 1956. Recent collections of some less common fishes in southern Illinois. Trans. Ill. State Acad. Sci. 48:23-26.

Huston, J.W. 1972. The vascular flora of Horseshoe Lake, Alexander County, Illinois. Master's thesis. Southern Ill. Univ., Carbondale.

Kendeigh, S.C. 1970. The brown creeper in Illinois. Ill. Audubon Bull. 153:19.

Minton, S.A., Jr., and J.E. Minton. 1948. Notes on a herpetological collection from the middle Mississippi valley. Amer. Midland Natur. 39:378-390.

Smith, P.W. 1948. Noteworthy herpetological records from Illinois. Chicago Acad. Sci. Natur. Hist. Misc. 33. 4 p.

Smith, P.W. 1971. Illinois streams: A classification based on their fishes and an analysis of factors responsible for disappearance of native species. Ill. Natur. Hist. Surv. Biol. Notes N. 76. 14 p.

Figure 6. Example of a computer printout and topographic map for a natural area, *continued*.

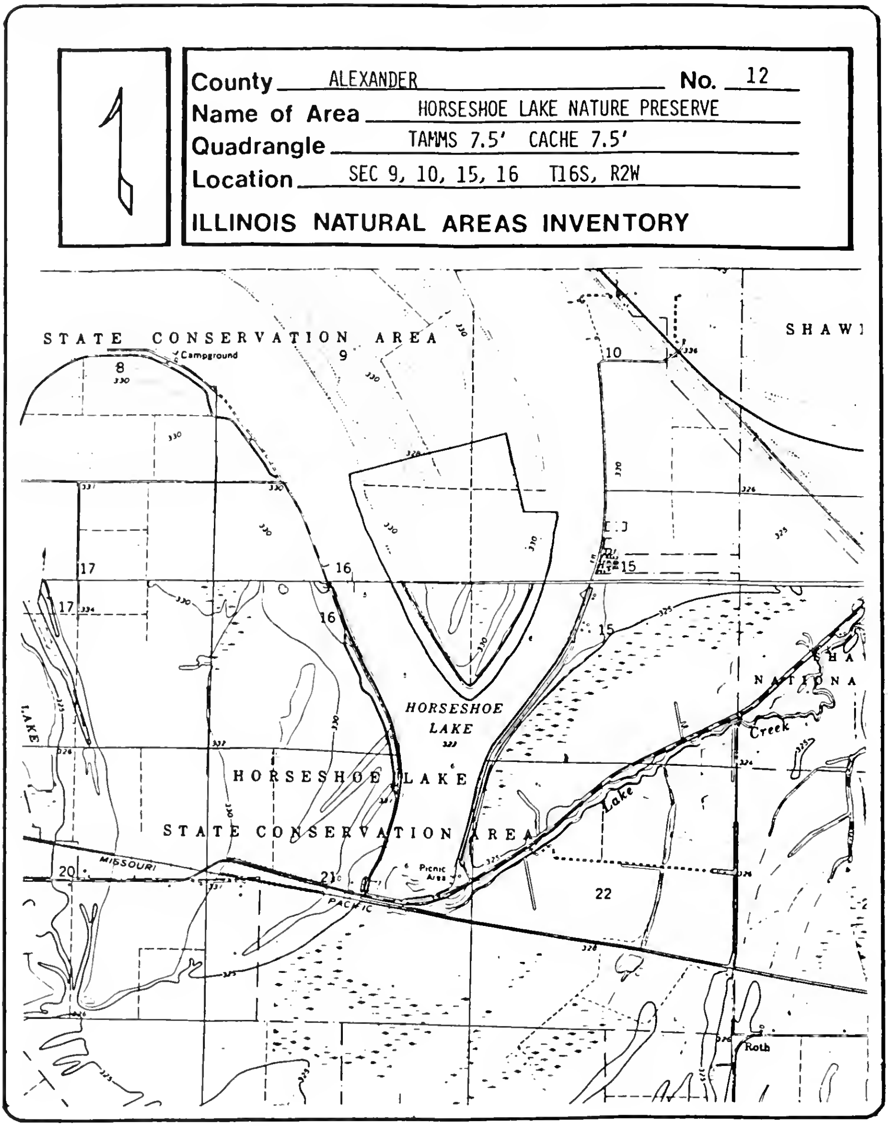

Figure 6. Example of a computer printout and topographic map for a natural area, *continued*.

ACREAGES

# of areas considered: 125
Total # of values considered(not including MDC's): 0

Community	GRADE A	GRADE B	GRADE C	GRADE D	GRADE E
1 . 1	0	27	540.7	21	0
1 . 2	318.5	532	4984.7	453.3	0
1 . 3	26	0	0	0	0
1 . 4	30	131	345.7	15	0
1 . 5	566.5	504	3163	241.5	0
1 . 6	56	417	1045.5	32	0
1 . 7	164	311.5	1204.5	41.6	0
1 . 8	0	0	0	0	0
1 . 9	2	0	0	0	0
1 . 12	16	0	51	3.4	0
1 . 13	0	0	0	0	0
1 . 15	2.5	85	181.9	5	0
1 . 16	0	21	191	44	0
1 . 17	0	0	0	0	0
2 . 1	1.1	.7	0	.7	0
2 . 2	2.6	1	0	.7	0
2 . 3	1	0	.5	0	0
2 . 4	122	93	312	46	0
2 . 5	0	0	0	0	0
2 . 6	8.5	30	6	1.5	0
2 . 7	0	4.5	190.5	6.4	0
2 . 8	179	18.3	199	34.5	0
2 . 9	0	.5	3.6	0	0
2 . 12	63	37.5	5.5	0	0
2 . 13	0	0	0	0	0
2 . 14	0	0	0	0	0
2 . 15	12.7	29.4	215.7	187.5	0
2 . 16	47	30	57	29.5	0
2 . 17	0	0	0	0	0
2 . 18	0	0	0	0	0
2 . 19	0	7	532.63	13.16	0
2 . 21	0	0	0	0	0
2 . 22	.6	22.7	552.8	8.9	0
2 . 23	10	6	5	18.5	0
2 . 24	0	0	0	20	0
2 . 25	0	0	0	0	0
2 . 26	79	15	9	3.8	0
2 . 27	0	3.1	4.4	39	0
3 . 1	0	2.5	4	0	0
3 . 2	0	0	25.2	0	0
3 . 3	0	0	2	1086	0
3 . 4	17	4	195	11.8	0
3 . 5	0	0	0	0	0
3 . 6	111	24	973	119	0
3 . 7	0	0	0	0	0
3 . 8	0	0	0	0	0
4 . 1	0	0	0	0	0
4 . 2	31	67.5	0	7.5	0
4 . 3	0	9.5	1	0	0
4 . 4	1.9	1.3	0	0	0
4 . 5	3.1	2.5	19	0	0
4 . 6	0	300	0	0	0
4 . 7	11	0	0	0	0
4 . 8	32.55	550.4	507.53	67.56	0
4 . 9	48	1.3	10	0	0
4 . 11	8.4	134	106.5	41.4	0
4 . 12	51	144	338.63	94.66	0

Figure 7. Example of a computer printout from a statistical program.

Appendix 19.
PRESETTLEMENT VEGETATION ATLAS OF ILLINOIS

The *Presettlement Vegetation Atlas* is an unpublished set of maps, at a scale of one-half inch per mile, which show the forests, prairies, and other natural features of Illinois at the time of the U. S. Public Land Survey in the early 1800's. The maps were made by copying the boundaries of the forests, prairies, barrens, marshes, swamps, lakes, and other features onto county highway maps from microfilm of the original township plats. The township plats are maps of each legal township in Illinois, drawn from the surveyors' field notes. The atlas has a supplement arranged by county that contains all notes about natural features that were written on the original township plats.

The atlas is the product of several hundreds of hours of hand-copying the forest-prairie border and the boundaries of other natural features in color from roughly 2,000 township plats. The supplement of notes transcribed from the original plats consists of about 285 typewritten pages.

The atlas was loaned to the Inventory by John White. Its main uses were to find cemeteries and railroads with potential for prairies, and to determine the presettlement vegetation of specific sites. Plate 4 has a section of one of the maps which illustrates its use.

Appendix 20.
SOME PROCEDURES FOR IDENTIFYING NATURAL COMMUNITIES

This appendix is a review of methods for recognizing natural communities by interpreting maps and aerial photos and by aerial surveys. The discussion is not a complete treatment of procedures, and most natural communities (Appendix 30) are not specifically mentioned.

Interpreting Maps and Aerial Photos

The use of standard black and white ASCS aerial photos (Section 9) is discussed. Most techniques for using topographic maps and soil maps are straightforward and conventional, so these maps are discussed only in special or unusual examples.

Forests

Most kinds of forest communities in Illinois can be predicted with a high degree of confidence by reading topographic maps. The natural communities are mostly distinguished on the basis of topographic position and soil moisture class. The forest soils of Illinois are generally deep and permeable, so soil moisture can be predicted on the basis of topography.

Aerial photos can aid in determining the exact boundaries between communities, and some tree species can be identified by an experienced interpreter if they occur in dense, monotypic stands. These species include tupelo, bald cypress, chestnut oak, post oak, cottonwood, sandbar willow, and silver maple. Other species can be identified by their distinctive growth form, foliage, or habitat. These species include red cedar, white cedar, and tamarack.

Prairies

It usually is not possible to distinguish between a natural prairie and any other grassland on an aerial photo, but sites with high potential for prairie can be selected with a varicty of methods. Railroads and cemeteries (Sections 15 and 16) have high potential for prairie remnants.

Soil maps can be used to find sand prairies. Hill prairies are visible on aerial photos as openings on steep, south to west-facing forested slopes. Wet prairies often occur in association with wetlands.

Natural black-soil prairie can sometimes be found by studying a series of older aerial photos of a suspected prairie. If the pattern of vegetation remains the same throughout the years, and there are no signs of disturbance, then the grassland may be a natural prairie. Some black-soil prairies have been found by comparing the characteristic tone, texture, and pattern of a known prairie with nearby grasslands that are on the same soil type.

Savannas

Maps and aerial photos were used only to find sand savannas, because natural remnants of typical savannas on finer-textured soils are almost nonexistent. (Seven remnants totaling 12.3 acres are known in Illinois.) Many examples of mesic and dry-mesic savannas on loess and glacial till soils can be found on aerial photos, but they are invariably too damaged by grazing to qualify as natural areas.

Barrens can rarely be detected with certainty on aerial photos, because they usually have a nearly complete tree canopy or cannot be distinguished from a disturbed forest community. The possible presence of barrens can be predicted by searching for narrow ridges and steep, exposed, south to west-facing slopes, particularly in areas where the glacial drift is thin over bedrock.

Wetlands

The 7.5-minute topographic maps are generally precise in depicting wetlands, but seeps are usually not shown. Fens and other seep communities can be identified by several means:

(1) A deep, steep-walled valley where a stream cuts through a glacial moraine has a high potential for seeps.

(2) Wet soil is dark-toned on aerial photos.

(3) Sedges that grow in fens have a characteristic, even gray tone on aerial photos.

(4) Peat deposits shown on soil maps are often in seeps and fens.

(5) Any uncultivated, level area at the base of a hill that is surrounded by cultivated land should be suspected as a seepage area.

(6) If a ditch follows the base of a hill, it often was built to intercept water flowing from seeps on the hillside.

Primary communities

Cliffs, eroding bluffs, and beaches are easily recognizable on maps and photos, but glades require more careful study. Glades are openings in the forest, almost always on south to west-facing slopes. The openings are light-toned compared with the surrounding forest, but they characteristically have many small trees and shrubs. Red cedars are almost always present, and these are very dark gray on aerial photos.

Limestone glades are often triangular or crescent-shaped, on south or southwest-facing points of limestone bluffs. The few, small shale glades in Illinois are similar in appearance to limestone glades. Sandstone glades are usually bands at the top edge of sandstone cliffs or along sandstone chutes (courses of intermittent streams across bare bedrock). The glades often have narrow, parallel bands of trees and shrubs that grow in zones of thin soil developed along weaker beds of rock.

Aerial Survey

Unless otherwise noted, the following discussion is limited to techniques that are applicable during the dormant season.

Forests

Forest communities can be identified from the air by using the same principles that apply to interpreting maps and aerial photos, but more species can be identified from an airplane. An experienced observer at a low altitude can identify most genera or species of trees.

Prairies

Most dormant prairie grasses have a red, yellow, or orange color that makes them prominent during the aerial survey. The grass stems become flattened against the ground by snow, and they fade as the winter progresses. Hill prairies are especially visible from the air because they are on prominent, exposed slopes and usually have red cedars.

Savannas

Natural savannas on fine-textured soil are almost nonexistent, so the aerial survey did not apply to them. However, sand savannas are relatively common, and an airplane was used to survey extensive tracts of sand plains and dunes with savannas. The savannas are easily recognizable from an airplane, but only the most disturbed ones can be eliminated during the aerial survey. The species composition of the vegetation has to be evaluated with ground surveys.

Barrens are difficult to recognize from an airplane unless they are exceptionally large and well developed. The herbaceous vegetation among the trees is important, but this is usually so sparse and obscured by trees and fallen leaves that it can hardly be seen from an airplane.

Primary communities

Glades are quite visible from an airplane because they are on prominent, exposed slopes, and they almost always have red cedars. The bedrock of sandstone glades has a light blue-green cast from a cover of lichens. Limestone glades have brownish or grayish outcrops. The ground in the few shale glades in Illinois has a purplish cast from lichens and weathered shale.

Appendix 21.
SOME PROCEDURES FOR DETECTING DISTURBANCES

This appendix reviews techniques for detecting artificial disturbances to natural communities by examining aerial photos, by aerial surveys, and by ground surveys. Only forests and prairies are discussed, but many principles that apply to prairies can be used with wetlands and savannas.

Examining Aerial Photos

This discussion applies to ASCS aerial photos that were used by the Inventory staff (Section 9). Examples are limited to general principles that can be explained without actual aerial photos.

Forests

Woodlots that have been protected from disturbances often have straight boundaries and square corners that follow property lines. A disturbed stand usually has an irregular boundary that follows steep slopes and wet areas. This indicates that the landowner has cleared as much timber as is economical, and the remainder has very seldom been protected from logging or grazing.

An old growth, undisturbed forest on soil that is not especially limiting to tree growth has a continuous, relatively even canopy with large-crowned trees. A canopy that is open, uneven, or composed of small-crowned trees usually indicates logging or grazing disturbances. A young to mature second growth stand has a dense, even canopy of small-crowned trees. A stand that has had recent, selective logging exhibits distinct, small gaps in the canopy. A stand that has recently been heavily logged has a ragged appearance. If such a stand has recovered for several years, it has a pebbly appearance, caused by shadows of older trees, which rise above a new canopy of young trees.

Small trees and openings in the forest canopy are not necessarily results of disturbance when they coincide with soil types and topographic

situations that might support flatwoods, xeric upland forests, wet floodplain forests, and similar communities.

Rectilinear or sharp changes in the canopy within a stand usually are the boundaries of timber cutting. A stereoscope is useful for determining the relative height of trees and irregularities in the canopy. Stereoscopes are generally not needed, except when concentrating on a specific site, and they are difficult to use with ASCS enlargements.

Grazing can be detected with the following clues and techniques:

(1) Look for livestock trails (thin, whitish lines) that extend from a pasture or barnlot into a woodlot. Care must be taken to distinguish intermittent streams and unimproved roads from stock trails.

(2) If the pasture immediately adjoining a woodlot is trampled bare, then the livestock in the pasture are being fenced out of the forest.

(3) A pond in a woodlot is usually for watering livestock.

(4) If there is an indistinct, uneven boundary between a woodlot and a pasture, then it is likely that the forest is grazed.

(5) If a woodlot is fenced, but trees do not extend to the fence, then it is probably grazed. Otherwise trees and shrubs would have invaded the open area between the fence and the forest edge.

(6) A forested slope between an upland pasture and a bottomland pasture is almost invariably grazed.

(7) A forest with large gaps in its canopy and broad areas in which the ground is evident is probably grazed.

Prairies

In contrast to forests, natural prairies often have irregular boundaries. Straight boundaries usually indicate that the prairie is fenced and grazed. Undisturbed prairies often persist in irregularly shaped patches that coincide with soil that cannot be cultivated or grazed. If a prairie remnant (or woodlot) is isolated in cropland, with no water source, and there is no livestock lane leading to it, there is a relatively high probability that it has not been grazed.

Prairies have been nearly eliminated from Illinois, so remnants that can be detected on aerial photos merit examination in the field unless the photo shows that the prairie has been severely disturbed. Even though prairies must be examined from an airplane or on the ground, aerial photos are useful for learning about past disturbances.

Parallel lines in a prairie may indicate past cultivation or mowing. The lines are caused by differences in vegetation along furrows or along ruts or gouges caused by mowing. The lines may persist for many years after the disturbance, and they do not necessarily indicate that the prairie is too disturbed to qualify as a natural area. Mowing may have little lasting effect on a prairie, but ruts from mowing in wet soil may persist for years. A prairie may recover from cultivation, especially if the soil is sand and there is an adjacent prairie remnant to serve as a source for colonizing the disturbed area.

On aerial photos, currently cultivated or mowed areas in a prairie are clear, bright, whitish areas, usually with sharp, straight sides. The mowed or plowed areas have a light tone because they reflect sunlight better than undisturbed grass.

Closely grazed grassland has an even gray tone. In contrast, an area with tall grasses or forbs has a coarser and more textured appearance, with greater variability in tones. Heavily grazed areas have whitish patches of bare soil or thin, light lines from livestock trails. Trampled areas are most prominent along fences, at gates, in fence corners, and around areas that provide feed, water, or shelter.

Examining old aerial photos

Examining old aerial photos of specific sites is important for several reasons. Past disturbances such as clearing, cultivation, and timber harvests may be detected that are no longer apparent on newer photos. The contrast in vegetation between different communities is sometimes greater on old photos. This is particularly true with flatwoods, hill prairies, and glades which were once more open but are blending with the surrounding forest because of woody plant succession.

Examining a series of aerial photos from different years increases the chance that an especially clear or useful photo will be found. For

example, Saline County was photographed one year when the leaves on the rare chestnut oak had their autumn coloration but the surrounding forest was still green. The stands of chestnut oak appear on these photos as prominent light-toned patches in the otherwise dark-gray forest. Some of the earlier photos have finer resolution and greater contrast than some of the newer prints.

Aerial Survey

A practically limitless number of techniques and clues can be used to detect disturbances during the aerial survey. The procedures described below are a sampling of ones used by the Inventory staff when conducting aerial surveys (Section 10).

Forests

The following clues can be used to evaluate logging disturbances from an airplane:

(1) Look for direct evidence of logging:

Stumps
Tops from felled trees
Logging roads
Open, uneven canopy from removal of trees

(2) Determine the age of the stand by noting the size and form of individual trees, and by studying the structure of the stand:

With experience, it is possible to judge the overall age of a stand by studying the size and form of individual trees. Young second growth trees are relatively small and slender, and have an immature growth form, with many ascending branches. Old growth trees are large, with relatively few, large, spreading or ascending limbs.

Trees that have sprouted from the stumps of cut trees are often multiple-trunked. (Grazing, burning, and clearing of the understory can also injure saplings and result in multiple-stemmed trees.)

Often the largest trees in a forest are poorly formed individuals that were never cut because they were unsuitable for lumber. Such trees are readily recognized from an airplane. If all of the largest trees are poorly formed, then the stand is probably second growth.

Young oaks in cut-over stands often retain their leaves throughout the winter. They are highly visible indicators of disturbance.

Recently logged floodplain forests characteristically display dense stands of yellow grass in winter.

Old growth stands of certain forest types have exceptionally large, well formed trees that are conspicuous from the air. For instance, outstanding floodplain forest along the lower Kaskaskia River invariably has huge bur oaks; and dry upland forest in the Shawnee Hills has massive post oaks if it is old growth.

(3) Determine the length of time since logging by noting the following:

Condition of stumps, which varies according to tree species and soil conditions.

Size and approximate age of trees that are replacing ones that were removed.

The following clues can be used to evaluate grazing disturbances from an airplane:

(1) Look for damage to the understory. This is difficult unless the damage is severe, because the branches of the overstory trees obscure and confuse the condition of the understory. The following clues and techniques are helpful:

It is possible to get a view of the understory from an airplane by looking into the edge of the forest at a low angle. Binoculars are useful for this.

A forest with a heavily damaged understory has a relatively clean appearance. This is especially apparent if the damage stops at a fence inside the woods and the grazed part can be compared with the rest of the forest.

A stand with a long history of grazing has an open canopy and overstory trees with unnaturally low, spreading limbs that have replaced understory trees. Even if grazing has ceased, the lower limbs will persist for years until gradually replaced by new understory growth.

(2) Look for other evidence of grazing:

Livestock and stock trails. (Trails are especially prominent on steep hillsides and radiating from gates. They are also prominent on the inside corner of a fenced, L-shaped woodlot, because the livestock take the shortest path between the arms of the fenced area. Livestock tend to form paths on the shortest or easiest route, so the paths often follow ridgetops or barriers such as creeks.)

Fences. (At least one side of the fence probably has been grazed at some time.)

Hogsheds, stock ponds, and watering tanks. (Ponds are rarely constructed in forests unless they are for watering stock.)

Trampled, bare earth (particularly along fences, in fence corners, and at gates).

(3) Look for thorny or unpalatable trees and shrubs that increase with grazing. Most have a characteristic growth form, phenology, or color that allows quick recognition from an airplane. Common species include multiflora rose, Osage orange, honey locust, hawthorns, gooseberries, European buckthorn, and red cedar.

(4) Look for indirect evidence of grazing or the lack of grazing:

If a woods adjoins a pasture and is not fenced from the pasture, then it is grazed to some extent.

If a wooded slope has cleared pastureland above or below it, then the woods is almost invariably grazed.

If a woodlot is isolated in cropland, then it probably is not grazed during the growing season, unless a fenced lane connects the woodlot with a barnlot.

Prairies

The second group of clues listed for detecting grazing disturbances to forests can also be applied to prairies. Livestock trails are especially prominent at gates, salt blocks, and feed bunks. On hill prairies, the trails form parallel terraces on the slope.

In the fall and winter, most prairie grasses are yellow, orange, or reddish-brown. Exotic cool-season grasses may be green, light yellow, brown, or whitish in winter.

Thorny and unpalatable shrubs such as red cedar, multiflora rose, and hawthorns indicate grazing. If the lower branches of shrubs are absent, this usually indicates that livestock are still grazing the prairie.

Only heavily disturbed prairies can be rejected during the aerial survey, because species composition can be examined in detail only by ground surveys.

Some apparent indicators of disturbance may actually be signs that a prairie has not been grazed recently and may have recovered to high natural quality. For example, a sand prairie that has a pine plantation probably has not been grazed since the trees were planted. A gravel prairie or dolomite prairie that has a gravel pit or mine may not have been grazed since the quarry was started.

Seasonal considerations

The dormant season, from late October to April, has the most advantages for aerial surveys. The interior of the forest is not obscured by a leafy canopy. Native prairie grasses are brightly colored and highly conspicuous. Clear, cold days allow the smoothest flights.

The low angle of the sun in midwinter has advantages and disadvantages. The crowns of trees are highlighted, so it is easier to determine the size and age of trees; but long, dark shadows obscure the understory and forest floor. Especially in the afternoon, the sun's rays are reddish, and the distinctive colors of bald cypresses and prairie grasses are enhanced. The observer has more problems with glare from the low angle of the sun, unless the sky is overcast.

A brief period in early spring when leaves and flowers are appearing has the most advantages for surveys of forests. The expanding leaves form a thin veil that accents the crowns of individual trees and shrubs, but the canopy is not so dense that the ground is obscured. A person familiar with the phenology of flowering plants can use this knowledge to much advantage. Many individual species can be identified by the color of their flowers. Shrubs often produce leaves before overstory trees, so the condition of the understory is more apparent in early spring.

Aerial surveys of prairies during the summer were not found to be effective, because prairie grasses cannot be distinguished from other grasses. There is little advantage to flying while forbs are in flower, because few species can be identified with certainty unless they characteristically form large, dense colonies. Weedy forbs are easily mistaken for conservative prairie species from an airplane.

Late summer and early autumn are best for aerial surveys of wetlands with herbaceous vegetation. Many forbs that are indicators of disturbance are in flower in late summer, and they can be identified by an experienced observer. The contrast between species of graminoids is greatest in early autumn, when each dominant species has a different color and texture. Killing frosts occur early in low wetlands because of cold air drainage, and the color of individual species changes from week to week after the first frosts, so the aerial surveyor should become familiar with the current condition of the vegetation.

Some ways that snow can aid aerial surveys are listed below to indicate the wide variety of techniques available to the aerial surveyor.

(1) A snow cover provides a white background against which forests can be examined. Without a snow cover, the form of individual trees is obscured by the surrounding trees, and the trees blend with the forest floor. With a snow cover, trees stand out as individuals, and the branching patterns are more apparent.

(2) Stumps are more easily seen in the snow, unless they are covered by a deep snow. As the snow melts, stumps are especially apparent because a ring of snow melts away from each stump before the rest of the ground is exposed.

(3) Large, old growth trees can be spotted more easily if snow clings to their large limbs after it has fallen from the branches of smaller trees.

(4) The contrast between grazed and ungrazed parts of a forest is increased by snow, especially if the forest is observed along a fence that separates the two parts of the forest. The snow-covered ground on the grazed side of the fence has a clearer appearance because the snow is less obscured by herbaceous vegetation and shrubs.

(5) A light, powdery snowfall causes grazing trails to stand out as white lines in a background of brown leaf litter. In deeper snow, active stock trails stand out as dark lines.

(6) Removal of the groundcover and understory by grazing can sometimes be detected by studying snow drifts. If the drifts extend very far into the forest from the edge of the woodlot, then there probably is not enough understory remaining to blunt the force of the wind.

(7) Livestock, fences, and livestock shelters can be detected more readily in the snow.

(8) Snow can enhance the visibility of hill prairies. Snow-covered hill prairies stand out as white patches among dark trees. As the snow melts, hill prairies are again accented because the snow melts from the prairies first, causing them to be brown patches against a background of snow.

(9) Snow persists on protected north and east-facing slopes after it has melted elsewhere. The persisting snow makes it possible to see every small ravine, which is an important aid in marking the location of small hill prairies in rugged topography.

(10) Surveying for seep springs is ideal after a fresh snowfall, because the springs and spring runs appear dark against the snow.

(11) Snow assists in the detection of small ponds and sloughs in forested land. If they are frozen, they appear as white patches, which makes them prominent in timber stands. If they are not frozen, they appear as blackish patches among the snow.

(12) Air escaping from the upper entrances of caves melts snow, which sometimes makes the mouths of caves more prominent. However, the white background from snow makes it impossible to detect caves from the air by looking for fog streaming from the entrances.

Ground Surveys

Introduction

Determining the degree of disturbance to forests and prairies by on-site inspections relied mainly on an evaluation of the natural quality of the vegetation (Appendix 22). Although all components of a natural community are important, plant communities are the best indicators of the past history and present condition of a community. Disturbances are reflected in the vegetation's structure (age, distribution, size, etc. of individuals) and species composition. Although the types and abundance of animals are good indicators of an area's natural quality (see King and Elfner, 1975), detailed surveys of animals were not needed to decide how a terrestrial or wetland natural community had been disturbed. The fauna is dependent on the plant communities, and an analysis of the vegetation provides information for predicting the kinds of animals that are probably present but are not apparent during brief surveys.

As described in Section 12, the vegetation was sampled or plant species lists were completed for high quality natural communities. These data were not used by themselves to determine the natural quality of an

area. Rather, the degree of disturbance was analyzed by studying the structure and composition of the vegetation, along with other indicators of disturbance such as unnatural changes in the soil or water. Some of the indicators that apply to forests and prairies are discussed in the remainder of this appendix.

Forests

A primary indicator of the history of a stand is the age of the overstory trees. The Inventory used the following classification to provide uniform terms for describing the age of a forest:

Age of stand	*Age of overstory trees*	
Old growth	Very old	120 yr. +
Old second growth	Old	90-120 yr.
Mature second growth	Mature	40-90 yr.
Young second growth	Young	20-40 yr.
Regrowth	Very young	10-20 yr.

The age classes for the forest stand correspond with age classes for individual trees. For example, an old growth stand has a predominance of very old (120 years or older) trees in the overstory. Sometimes a stand consists of a mixture of different ages, and must be described, for example, as "all-aged second growth," or "young to mature second growth with scattered very old trees."

Assessment of damage from grazing is complicated by the different rates at which forests recover from grazing, but the basic terminology used to decribe current grazing damage was as follows:

None.--There is no evidence of grazing, or almost no evidence.

Light.--Some evidence of grazing damage is present. A browse line is developing, and natural understory reproduction has stopped. There is a small gap in the age of the understory, and an increase in thorny species.

Moderate.--Evidence of grazing is obvious. There is a definite gap in the natural understory, and thorny species are well established. Grazing trails are well established.

Heavy.--Understory has been replaced by thorny shrubs. Gaps are beginning to develop in the overstory.

Severe.--Large gaps have developed in the overstory, and thorny species are entering the canopy. The edges of the woods, along fences (and particularly in fence corners) may be without trees or shrubs, due to continual, prolonged trampling.

Very severe.--Understory has been eliminated or is dying. Overstory trees are being killed. Soil is bare and eroding.

Useful descriptions of the effects of grazing and the stages of recovery from grazing are in studies by Day and DenUyl (1932) and DenUyl, et al. (1938).

Examples of clues for determining the history of disturbance of a forest are listed below:

(1) In a typical, undisturbed, old growth forest, the overstory trees have tall, straight, clear trunks, with relatively few, large, ascending and spreading limbs in the canopy. On dry soil, the trees are smaller and the crowns may be more widely spreading. An experienced person can judge the age of a tree with close accuracy by observing the site conditions and the size and form of the tree. The Inventory staff used increment borings when necessary to determine the age of individual trees.

(2) Forked trunks result from injuries such as fire and grazing. Multiple-trunked trees may be stump sprouts, the result of logging.

(3) Trees with large lower limbs and broad crowns usually indicate a past history of grazing. This open-grown appearance is illustrated and discussed by Bennett (1977). Or, the stand may be a former savanna that has succeeded to a forest.

(4) An unusually high or low density of trees within a size class indicates past disturbance, usually logging or grazing. The disturbances have either removed a size class or suppressed growth or reproduction. After the disturbance, an unusually high density of young trees may result as the stand recovers.

(5) An abundance of certain species indicates grazing. These include thorny and unpalatable species such as multiflora rose, honey locust, Osage orange, poison ivy, hawthorns, prickly ash, gooseberries, and blackberries. Some understory species (such as musclewood and most viburnums) are sensitive and decrease with grazing. Other species such as elms and sugar maple decrease under grazing pressure but may become abundant after the livestock are removed.

(6) The age of trees in a stand may indicate the period of grazing. For example, if the oldest thorny invaders are 40 years old, then grazing probably began 40 years ago. If a formerly grazed upland forest has 10-year old hackberries, elms, and sycamores, then grazing probably ceased 10 years ago.

(7) Information from owners or local residents can help reconstruct the history of disturbance of a woodlot, but these sources often do not reliably recall past disturbances.

Prairies

Vegetation characteristics that may indicate disturbances include:

(1) Low densities of either forbs or grasses.

(2) Clones and dense colonies of single species.

(3) Abundance of species that increase with disturbance.

(4) Absence of species that decrease with disturbance.

Soil characteristics that indicate disturbance include:

(1) A plow layer, of well-mixed soil (often with a loss of natural soil structure, and a compacted plow sole at the lower boundary of the plow layer).

(2) Removal of the A horizon by erosion or mechanical means (determined by comparing the depth of the A horizon in similar soil on adjacent land).

Appendix 22.
GRADING NATURAL QUALITY

Natural quality is defined as a measure of the effects of disturbance to a natural community. The concept is introduced and summarized in Section 7. Natural quality is expressed by a system of grades, which are affected by both artificial and natural disturbances. Some procedures for detecting disturbances are in Appendix 21.

Grading Artificial Disturbances

The grading system provides terms for describing the relative amount of successional instability or change in a community's natural diversity, species composition, and structure due to disturbance. The grades are summarized as follows:

Grade A: Relatively stable or undisturbed communities

Grade B: Late successional or lightly disturbed communities

Grade C: Mid-successional or moderately to heavily disturbed communities

Grade D: Early successional or severely disturbed communities

Grade E: Very early successional or very severely disturbed communities

Grade A

Relatively stable or undisturbed communities.--Ideally, a Grade A community has a structure and composition that has reached stability and does not show the effects of disturbance by humans. However, this grade does include a range of conditions: the community may be gradually changing, or it may have been lightly disturbed. Examples: (1) old growth, ungrazed forest, (2) prairie with undisturbed soil and natural plant species composition, (3) wetland with unpolluted water, unaltered water level, and natural vegetation.

Grade B

Late successional or lightly disturbed communities.--A Grade B community is a former Grade A community that either (1) has recently been

lightly disturbed, or (2) has been moderately to heavily disturbed in the past, but has recovered significantly. If the community was recently disturbed, it was not disturbed so heavily that the original structure and composition was destroyed. If the community was disturbed in the past, it has reverted so that it is reaching stability and is no longer rapidly changing. Examples: (1) old growth forest that was selectively logged 5 years ago, (2) old second growth forest that had a moderate grazing effect, but now is in the late recovery stage, (3) prairie with somewhat weedy composition because the soil was graded 15 years ago, (4) wetland in which original water levels have been altered, which changed species composition locally, but did not destroy the structure and natural diversity of the community.

Grade C

Mid-successional or moderately to heavily disturbed communities.--A Grade C community either (1) has been moderately to heavily disturbed (and may or may not be reverting), or (2) has been severely disturbed and has reverted significantly. The disturbance to a Grade C community has been so great that the original structure was destroyed, and often the composition has been changed significantly. This grade includes a broad range of degrees of disturbance and of recovery. Examples: (1) heavily grazed, old growth forest, (2) young to mature second growth forest, (3) prairie that has been grazed so long that many native species have been replaced by weeds, (4) wetland with artificial water level that has changed the structure and composition of the vegetation.

Grade D

Early successional or severely disturbed communities.--A Grade D community either (1) has been severely disturbed and has not recovered significantly, or (2) has been very severely disturbed but has begun to recover. A Grade D community has been so heavily disturbed that its structure (and usually composition) has been severely altered and is rapidly undergoing succession. (If the disturbance is constant, such as with continual grazing, the community may be stable--not succeeding.) Examples: (1) recently clearcut forest, (2) mature second growth, severely grazed forest, (3) railroad prairie remnant with graded soil,

dominated by weeds, with many native species missing, (4) wetland that has been artificially flooded or drained, greatly changing the vegetation.

Grade E

Very early successional or very severely disturbed communities.--A Grade E community has been so severely disturbed that the original community has been removed, and either (1) the site is going through the first stages of secondary succession, or (2) the natural biota is nearly gone. A Grade E community has very few or no higher plants or animals of the original community, and the land surface is often altered. Examples: (1) newly cleared land, (2) cropland, (3) improved pastureland, (4) railroad embankment, (5) paved parking lot.

Grading Natural Disturbances

The concept of grading natural quality originally evolved to describe the relative amount of change in a community due to direct, artificial disturbance by humans. However, natural disturbances often affect a community in a manner similar to unnatural disturbances. Two examples:

(1) An old growth, ungrazed upland forest is Grade A. If this forest is severely disturbed by a tornado, it may appear to have been clearcut by humans. Even though the forest has never been disturbed by people, an "A" grade is misleading because the trees are felled. However, a "D" grade is also misleading, because the forest was not affected by people.

(2) An open community of pioneer herbs and invertebrates on a river bluff of eroding glacial drift may be completely untouched by people because it is inaccessible and because erosion would remove any evidence of human disturbance. However, it would be misleading to give a naturally disturbed community such as this the same grade as a stable, undisturbed community.

A classification of successional types provides a framework for grading naturally disturbed communities and distinguishing them from artificially disturbed areas:

Relatively stable or undisturbed communities

Secondary successional communities caused by artificial disturbance

Secondary successional communities caused or maintained by natural disturbance

Primary successional communities caused or maintained by natural disturbance

Formerly stable communities now undergoing further primary succession

Relatively stable or undisturbed communities

These are typical Grade A communities, described in the previous section. The type may be undergoing gradual changes. The community may be maintained by fire or unusual soil, but it is stable under natural conditions. Although this type is described as "undisturbed," it includes communities that are lightly disturbed.

Secondary successional communities caused by artificial disturbance

A community may be disturbed and undergo secondary succession because of natural disturbances such as windstorms, diseases, insect outbreaks, severe fires, and a temporary, unusually high water table. These disturbances are not continual: often they are one-time, catastrophic events, and they do not always maintain the community at an earlier stage of succession. An old growth forest damaged by wind would be graded as follows:

B*n*: Enough canopy trees removed to approximate heavy selective logging

C*n*: Most overstory trees downed, leaving only young to mature trees

D*n*: Forest leveled by windstorm, leaving only saplings and shrubs

Communities affected by other natural disturbances are graded in a manner similar to the preceding example. For instance, the grade of a forest damaged by death of American elms from Dutch elm disease would depend on the percentage of the trees removed from the stand.

Primary successional communities caused or maintained by natural disturbance

Some communities either are (1) created and undergo succession due to natural disturbance, or are (2) kept perpetually youthful by natural

disturbance. In the first group are riverbank forests, and in the second group are young tree and shrub communities on river bluffs of eroding glacial drift. The grade of these communities depends on the stage of succession. A riverbank forest would be graded as in the following example:

B*n*: Old silver maple forest: overstory trees are old to mature. The stand has reached stability because trees in the *very old* age class are removed by floodwaters.

C*n*: Mature to young silver maple forest: overstory trees are mature to young. The stand usually is not stable: it may become older in time or floodwaters may keep the stand relatively young.

D*n*: Very young riverbank forest: trees are very young. Common trees are black willow, cottonwood, silver maple, and sycamore.

E*n*: River bar: exposed alluvium with no vegetation or only herbaceous vegetation.

Formerly stable communities now undergoing further succession

Many prairie and savanna communities are undergoing succession that is changing the structure and composition of the community, or even eliminating the community. These communities were originally maintained by fire. The absence of fires in these communities is a natural disturbance caused by humans. The natural quality of these communities depends on the degree of change from the condition that could have been expected if the pre-European settlement condition of frequent fires had continued. For example, a prairie would be graded as follows:

B*n*: Sparse or scattered woody invasion, which probably has not eliminated any prairie species.

C*n*: Heavy woody invasion, which probably has eliminated some prairie species, and which threatens to soon eliminate the prairie unless management is started.

D*n*: Former prairie, covered by brush or young trees, with only scattered prairie plants.

The presence in low numbers (or in small patches) of trees and shrubs that are normally found in prairies does not affect the grade. Small stands of woody invasion are natural disturbance features that do not lower the grade: the grade is lowered only if an area that is large enough to map has changed or is changing because of recent woody invasion. Savannas that are becoming closed forests, and other communities that are undergoing similar succession started by people are graded according to the degree of change from presettlement conditions.

Naturally Disturbed Communities as Significant Features

A community graded B*n* should be included as a significant feature in the same manner as a typical Grade B community. Because of natural disturbances, some floodplain communities are rarely if ever Grade A, and might not be included in a Category I natural area unless Grade B*n* examples qualify as significant features. The only Grade C*n* communities that should qualify as significant features are ones that are the least disturbed or only remnants of a particular community. For example, Dutch elm disease has so heavily disturbed some forest communities formerly dominated by American elms in the Northeastern Morainal Division that the remaining stands are Grade C*n*. Even though the natural community is heavily disturbed, the largest and least disturbed remnants will qualify as significant features. Otherwise, Grade C*n* communities should be treated as typical Grade C communities: they may be included in a natural area to add diversity to an already-identified natural area. Grade D*n* and Grade E*n* areas should also be included in natural areas because they are integral parts of the entire natural community that are important to include in a nature preserves system.

Appendix 23.
SOME PROCEDURES FOR FINDING RAILROAD PRAIRIES

This appendix supplements the discussion of the railroad prairie survey in Section 15 by giving more detail about procedures that should be of interest to others considering similar surveys.

Preparation for the Field Survey

Several factors that affect the potential for significant prairie remnants were used in deciding which lengths of railroad should be surveyed. The usefulness of these factors is discussed in the following paragraphs:

(1) *A railroad that crosses a former prairie region has greater potential for prairie remnants than a railroad through forest land.*--The location of prairies at the time of settlement was determined by a presettlement vegetation atlas (Appendix 19). These maps were used to eliminate railroads that cross extensive forested areas. The atlas was ideally suited for this purpose because both the railroads and the boundaries of the prairies are shown on its large-scale maps. In the absence of the vegetation maps, county soil reports could have been used; however, the soil maps vary greatly in usefulness and are much more difficult to use. The assumption that railroad prairies are found on prairie soil is logical, but significant stands of prairie vegetation occur on soil that is transitional between prairie and forest. Much of the land mapped as timber by the Federal land surveyors was actually savanna. Maps by Anderson and Anderson (1975) show that about one-quarter of the land depicted as timber on the original survey plats of Williamson County was open forest with between 19 and 40 trees per acre. Consequently, one must be careful about eliminating railroad lines because they appear to cross forested land. Several researchers, such as Shimek (1913, 1925) and Thomson (1940), have noted that prairie plants spread along railroads and highways, but the Inventory found no examples of high

quality railroad prairies on forest soil.

(2) *A railroad may have a greater potential for prairie if the railroad is closely paralleled by a road, so that there is an exceptionally wide strip of idle land shared by the rights-of-way of the road and the railroad.*--This assumption did not prove true. If the strip of land between the road and the railroad is exceptionally wide, then it is almost invariably cultivated if the soil is suitable. Also, disturbance to the soil between a road and a railroad is usually compounded because the land was disturbed by both road and railroad construction.

(3) *An exceptionally wide right-of-way has greater potential for prairie than a narrow one.*--This assumption is true unless the right-of-way was made exceptionally wide to accommodate an extra roadbed, a large ditch, or some other feature. Also, if a right-of-way has an exceptionally wide strip of land outside the embankments and ditches, it is nearly always cultivated if the soil has not been removed or the soil is not poorly drained. The width of a right-of-way can be measured from aerial photos with a magnifying lens and reticle. However, a better clue to the presence of excess land that could have prairie is the uniformity of the right-of-way's width: if examination of aerial photos reveals that a right-of-way continually broadens as it crosses valleys and narrows as it crosses level uplands, then the right-of-way is only wide enough to accommodate the railroad embankments.

(4) *The potential for significant prairie decreases with increasing disturbance of the right-of-way.*--One can detect disturbances such as earthmoving, cultivation, and woody invasion by studying aerial photos. However, these disturbances are usually so local or discontinuous that no significant length of railroad could be eliminated because of such disturbances.

(5) *Railroad lines that were constructed relatively recently would have relatively little potential for prairie remnants.*--A study of old maps reveals that most railroads in Illinois were built during a

relatively short time, so most railroads have about the same potential for prairie. Prior to 1840, only 26 miles of railroad were operating in Illinois, although other lines were started (Tanner, 1840). Little more track had been laid by 1851, when work began on the Illinois Central Railroad, stimulated by a grant of 2.5 million acres of Illinois land (Illinois Central Rail-Road Company, 1856; Gates, 1934). By 1856 the main line of the Illinois Central had been completed, and several more railroads were under construction (Starr, 1929; Stover, 1975). Most of the railroads were built within the next few decades: little more than 1,000 miles (less than 10%) of the cross-country lines in Illinois were built after 1909 (see map by George F. Cram Company, 1909). Some of the lines built after 1909 cross wet and sandy soil, and still have prairie remnants. Consequently, relatively few miles of railroads were eliminated because they were built recently.

Using the factors listed above as guidelines, the Inventory prepared county highway maps showing which railroads needed to be surveyed. Early tests had wrongly indicated that finding prairie remnants from an airplane was ineffective, so the staff began to prepare county maps to be used while checking railroads from crossings and from roads paralleling the tracks. Because such ground surveys are very time-consuming, the maps showed exactly which segments of each railroad needed to be checked. The railroads were color-coded to show: (1) where the tracks crossed (a) prairie soil and (b) forest soil, (2) where the right-of-way was exceptionally wide, with room for undisturbed prairie, and (3) where a road paralleled the railroad. These detailed maps were discontinued and were not used as intended because further tests showed that an aerial survey was effective. Since whole lengths of railroad could be surveyed rapidly from an airplane, it was not necessary to know exactly which small segments had no potential for prairie.

Aerial Survey

The aerial survey conducted during the fall proved very effective for finding undisturbed prairies. The high quality prairies generally

are obvious, dense sheets of red-orange grass. However, some large, dense stands of prairie grass grow on excavations where all the soil has been removed. Prairies that have not burned for years have a deep accumulation of duff, with few fruiting stalks, and these prairies are not so obvious from the air, but they have a characteristic color and texture that can be detected. The pattern of vegetation is an important clue to its natural quality: irregular, discontinuous patches and clumps of prairie grass scattered among weeds and Eurasian grass indicate reinvasion of prairie after severe disturbance. Bands of prairie grass that do not extend to the edges of the right-of-way indicate that the prairie is in ditches.

Appendix 24.

SELECTING CEMETERIES TO BE SURVEYED FOR PRAIRIE AND SAVANNA REMNANTS

The following is presented in the interest of people who might conduct a cemetery survey in other states.

Finding Cemeteries

The most productive way to find cemeteries in Illinois was to examine topographic maps and county highway maps. The 15-minute USGS topographic quadrangles are less likely to omit cemeteries than the newer 7.5-minute series. Topographic maps and highway maps each show cemeteries that the other kind of map does not show: in a sample of 143 cemeteries in three counties, 22% were shown only on topographic maps, and 14% were shown only on county highway maps.

A genealogical society that has completed a thorough inventory of burials in a county can often find twice as many gravesites as are shown on maps. The Inventory found that these additional cemeteries have almost no potential for significant prairie or savanna remnants. Many of the gravesites are so small and obscure that they are very difficult to find. Usually they are only large enough for a few burials. Most are in forested areas or are overgrown with shrubs.

Selecting Cemeteries

The Inventory used the *Presettlement Vegetation Atlas of Illinois* (Appendix 19) to determine whether a cemetery had potential for a significant prairie or savanna remnant. This source was preferred to soil maps because (1) the atlas was a set of county highway maps with cemeteries on them, (2) the atlas was available for the entire state, and (3) it sometimes was not possible to quickly determine whether a particular area had prairie soil or forest soil on a soil map. Savannas were usually mapped as forests by the Public Land Survey that was a basis for the presettlement vegetation atlas, so soil maps were used to find sand areas that could have supported savannas.

The staff attempted to reduce the number of cemeteries to be surveyed by learning which ones were established after about 1900 when almost all upland prairie would have been farmed. The following sources were explored:

Old atlases.--The atlases often were not accurate or complete regarding cemeteries. The staff stopped testing atlases as soon as it was discovered that two cemeteries with outstanding prairie remnants were not in atlases.

State agencies.--Despite persistent rumors and a lengthy and complicated search, the Inventory found no State agency that maintained the needed information.

Genealogical societies, historical societies, and libraries.--About 90 genealogical and historical societies were contacted by mail, and information was requested in newsletters of several societies. Almost all responses stressed the oldest cemeteries instead of listing the newer cemeteries as requested. Records in iibraries and lists of cemeteries compiled by other groups did not have enough information useful to the Inventory's purpose to be worthwhile extracting.

Custodians of cemeteries.--Form letters were sent to a test group of about 100 cemetery custodians. Responses almost always indicated that the cemetery was established before 1900. This method would not have been efficient for rejecting cemeteries.

There would have been such a low return for the effort from any of the above methods that they were not used.

Appendix 25.

CRITERIA FOR DESIGNATING A SPECIES AS RARE, THREATENED, OR ENDANGERED

Consideration of a Species' Population Status

The following criteria were adapted for use in Illinois by Richard H. Thom of the Illinois Endangered Species Project from the Maine Critical Areas Program report (Adamus and Clough, 1976). They are factors to be considered when determining the desirability and suitability of protecting and managing a species that may be rare, threatened, or endangered. The guidelines were used during the workshops conducted by the Endangered Species Project.

(1) *Relationship of the species' range in Illinois to its total range:*

(a) The periphery of the species' range occurs in Illinois.

(b) Illinois is well within the species' range.

(c) Illinois population is disjunct or relictual.

(2) *Spatial distribution* in Illinois, the Midwest, and in its entire range (after Drury, 1974):

(a) A few individuals or groups occur at widely scattered localities over a large geographic area of what appears to be suitable habitat.

(b) The species is found in very small numbers in each community where it occurs, but it occurs in many suitable areas over its geographic range.

(c) The species is restricted to so few localities that it is considered rare even though it may occur in relatively large numbers at each locality.

(3) *Endemicity*:

(a) Endemic to Illinois

(b) Endemic to the Midwest

(c) Not endemic to Illinois or to the Midwest

(4) *Relative abundance* in Illinois, in the Midwest, and in its entire range as estimated by probable site abundance:

(a) Five or fewer sites in Illinois
(b) Six to 15 sites in Illinois
(c) More than 15 sites in Illinois

(5) *Probable change in population* in Illinois and in the species' entire range during the past decade and century:

(a) Status change in Illinois during the past 10 years: (1) decreasing, (2) stable, or (3) increasing

(b) Status change in Illinois during the past 100 years: (1) decreasing, (2) stable, or (3) increasing

(c) Status change in entire range during the past 10 years: (1) decreasing, (2) stable, or (3) increasing

(d) Status change in entire range during the past 100 years: (1) decreasing, (2) stable, or (3) increasing

(6) *Relative habitat specialization* in Illinois:

(a) High degree of specialization: the species has very special requirements for at least some phases of its life cycle

(b) Moderate degree of specialization

(c) Low degree of specialization: the species can live in a great variety of habitatis, if necessary

(7) *Probable site persistence* in Illinois.--This is the probability that a species (not necessarily the same individual) will occur in a given place or small area for a majority of years over a 25-year timespan, assuming there to be no human disturbance of habitat or other detrimental human intervention, and reproductive success is assumed to be close to normal for the species:

(a) High site persistence: the species can be expected to remain in or return to the same small area year after year

(b) Moderate site persistence: the species cannot be expected to remain in or return to the same small area year after year, although they tend to do so

(c) Low site persistence: there is little probability that the species will remain in or return to the same small area year after year

(8) *Seasonal mobility*:

(a) Migratory: most members of the species migrate across state boundaries between summer and winter seasons

(b) Regionally mobile: most members of the species move shorter distances within the state or between neighboring states during the year

(c) Locally mobile: many members of the species may move or wander distances ranging from one-half to 10 miles either as regular travelers over a home range of that size or irregularly in response to seasonal changes in their food supply and general environment

(9) *Probable response to protection of habitat.*--Would the species derive a real benefit by having specific areas of its habitat protected? Is scarcity of suitable habitat the limiting factor for the species' occurrence in Illinois?

(a) High positive response to habitat protection

(b) Moderate positive response to habitat protection

(c) Low positive response to habitat protection

(10) *Area size needs.*--This includes the area needed for all the life needs (breeding sites, territory, feeding grounds, etc.) during the breeding season:

(a) Generally more than 300 acres

(b) Generally 100 to 300 acres

(c) Generally 10 to 100 acres

(d) Generally 1 to 10 acres

(e) Generally less than 1 acre

(11) *Reasons for status change*

(12) *Occurrence in Illinois.*--Exact locations and presumed range

Other Considerations

At more than one of the endangered species workshops, the following question arose: *Should a species that occurs at very few sites in Illinois be kept off the endangered species list if all these populations are already protected?* A species was not excluded solely because its entire population in Illinois is protected: this would in effect ignore the significant feature of an area where the species occurs and would often deny the reason the area was protected. Also, a species with a very low population level, restricted range, or specialized habitat is so vulnerable to disturbances that it is usually endangered even if its habitat is managed with preservation in mind.

Three other questions arose at the workshops:

Should a species be excluded from the endangered species list to keep from drawing the attention of collectors?

Should a species be excluded from the endangered species list so that biologists will not be restricted by law from collecting or studying the species?

Should a species be listed so that money will be made available from government programs to study the species?

Most workshop participants agreed that the above questions are legitimate concerns; but they should be kept separate from determining whether a species is endangered on the basis of population characteristics.

Appendix 26.
FIELD SURVEY FOR ENDANGERED PLANTS

Donald R. Kurz

Most fieldwork specifically for locating endangered plants was during the second field season, after information needed for a determination of each species' status was gathered. Without knowing which plants were endangered or threatened, the field survey and subsequent data gathering would not have been practical. The success rate at which species could be located was in the range of 15 to 40%. Although this was not nearly as successful as could be hoped for, it did provide up-to-date information on the condition of sites from which the species were once known to occur.

Preparation prior to the field search often enabled the fieldworker to decide whether a search for a particular species site would be needed. Examination of recent aerial photos was important to confirm that the site still existed. Contacting the person that collected the plant in question sometimes revealed information that could not be derived from the herbarium label. The occurrence of one plant specimen in the herbarium for a particular county was sometimes misleading in regard to the general distribution of the species. Sometimes a botanist would collect a plant at one site for a county record but would fail to collect or record the occurrence of the plant at other localities in the same county. One plant that was known from three counties in the southeastern part of the state was being considered as a threatened species, but upon contacting the original collector of the three county records it was revealed that the plants occurred abundantly throughout the counties in suitable habitat.

Contacting the original collector also provided more detailed and accurate information about the species and its location. One particular interview revealed that the collector had reversed the quarter-quarter sections in the legal descriptions on all of the herbarium labels. This often misplaced the plant's location by one-half mile.

Some of the earlier botanists used county and state road maps to describe the location for plants collected. As roads deteriorate, and new ones replace them, the route followed is not always the same. When there was some question about the location of a site, it was often helpful to use an older road map that would have been used by the collector.

Searching for plants in the field met with varying success and often depended upon the condition of the plant. By studying the phenology or time when the flowers were at antheses, the success with finding a plant was greatly increased. Various plant species of concern with similar flowering dates could be sought on the same trip by planning the route and limiting time at each site.

Appendix 27.
DETERMINING PRESERVATION PRIORITIES

Introduction

The most important part of a system for choosing potential nature preserves is a list of features that merit preservation. But once sites with significant features are found, the task is to set priorities for acquiring or negotiating preservation of these areas.

The Department of Conservation specified that the Inventory should not rank natural areas according to their priority for preservation. Instead, the Department intends to use certain of the data listed in Section 13 to rank areas with the aid of a computer program. The Inventory developed a computer program for the Department that has options for adding or deleting evaluation criteria and for varying the weights assigned to factors. This ranking system is in the early stages of use, and it may prove to be useful for making quick comparisons. It is one of several aids for setting preservation priorities.

Considerable effort has been devoted by preservationists to developing schemes for priority ranking. Among these are numerical scoring systems developed by the Illinois Nature Preserves Commission (1969), the Illinois Department of Conservation (1972), Tans (1972, 1974) for Wisconsin, Sargent and Brande (1975, 1976) for New England, and Gehlbach (1975) for Texas. Wright (1977) developed a ranking system for Great Britain and produced a helpful comparison and criticism of six other schemes. Fell, et al. (1972) discussed the criteria used for evaluating potential Illinois Nature Preserves, and Jenkins (1977) reviewed the criteria for selecting natural areas in The Nature Conservancy's Heritage Programs. A clear and thorough introductory discussion of the problems and approaches of choosing sites to preserve is in *A Nature Conservation Review*, edited by Ratcliffe (1977).

Evaluation Criteria

Natural characteristics

Characteristics such as natural quality, endangered species, diversity, and rarity of communities are in this group. Most natural characteristics are considered to be more important in priority ranking schemes than management, use, or acquisition factors.

Management and use criteria

The most important factors in this group appear to be the adequacy of buffer land and the potential for maintaining the area's significant features. Some authors have concluded that natural areas should be protected without regard to factors such as educational value, scenery, access, and similar criteria--provided that the area is not so vulnerable to surrounding influences or irreversible deterioration that it cannot be preserved. (Five such areas were identified by the Inventory among 610 ecological areas.)

Acquisition factors

Two practical considerations are sometimes overriding influences in determining preservation priorities. These are *availability* and *threats*.

Availability.--An area that is available through a willing seller, bargain sale, donation, or dedication may be preserved ahead of an area that is more valuable but is not available. Preserving an area that is less valuable but available may be justified, but it is important to consider future management needs and how well the area's significant features are represented in other preserves.

Threats.--An area may be given priority for preservation if it is threatened with destruction. Such preservation efforts may be rationalized by reasoning that all natural areas should be preserved and by hoping that later efforts will assure preservation of all areas. Some preservation programs may not proceed beyond reacting to crises, and often the money and interest needed to protect an area cannot be generated until the area is slated for development. Sometimes preservationists are unaware of an area until plans for development are announced. It is difficult to work on preserving an area that is not threatened

while allowing another site to be lost, but responding to crises often results in protecting less land at greater cost than if preservation had been negotiated before the area was threatened.

Numerical Ranking Systems

Structure of ranking systems

A typical numerical rating system has the following characteristics:

Evaluation factors.--Factors are often placed in two major groups: (1) natural characteristics, and (2) protection and use characteristics. A third group of acquisition factors (availability and threats) is sometimes separated from protection and use characteristics.

Relative ratings.--This is a method of rating the value of each factor on a common scale: high, medium, or low; 1, 2, 3; etc.

Weighted factors.--Factors are weighted to indicate their relative importance in determining the overall value of an area. For example, an important factor that rates *high* might score 15 points, and a less important factor that rates *high* might score 5 points. Factors are usually stated so that positive ratings are possible for all factors. For example, *management problems* (a negative attribute) are treated as *manageability*, which can be considered a positive attribute.

Weighted scores.--The weighted score is computed for each factor by multiplying the relative rating by the weight assigned for that factor. For example, if a factor is rated *medium* (2 points) on a scale of 1 to 3, and each rating point has a value of 5, then the weighted score is 2 x 5 = 10. Some rating systems are simplified by having the weighted score already computed for each relative rating. In the above example, a weighted score of 10 points would be automatically assigned to a *medium* rating without the need to multiply 2 x 5.

Total score.--Weighted scores for each factor are summed to compute a final, overall preservation value score.

Problems with the design of ranking systems

Deciding which factors to evaluate.--Most rating systems generally agree about the basic kinds of factors, but they differ because some

factors may be combined with others, and some factors may not be considered. For example, *scenic value* and *presence of hazardous situations* may be listed as separate factors, or may be combined under one factor related to *public enjoyment*, or may be omitted altogether.

Interdependence of factors.--Often a negative factor varies in direct relation to a positive factor. For example, *management problems* usually increase with an area's *size* and the presence of *unique features*. *Accessibility* may be considered a positive attribute because it allows more people to use an area, or it may be considered a negative attribute in relation to wilderness quality.

Assigning weights.--The relative value assigned to each factor is one of the most important and most difficult steps in designing a prioritization scheme.

Problems with the use of ranking systems

Interpretation of guidelines and criteria.--Although some factors can be quantified and all can be defined, the evaluator invariably has to make qualitative judgements of some factors. Interpretation by different evaluators will result in discrepancies in the evaluations. Independent ranking of the same area by two evaluators, followed by comparison of the results, is a good way to determine ambiguities and limitations of a ranking system.

Comparison of dissimilar areas.--It is best to rank areas with different categories of significant features (such as outstanding fossil sites and endangered species habitats) separately.

Misleading simplification.--If the scoring system results in a single number as an overall evaluation, then it probably is best to use a large number of criteria (more than 20). In this way, errors in judgement about individual factors are less likely to affect the final score, provided there is no consistent bias by the evaluator. Tans (1974) expressed an opposite viewpoint: he stated that the more factors involved in evaluating an area, the more averaging there will be, masking an area's outstanding qualities and deficiencies. This is true if the area is ranked by a single numerical value based on all factors combined; the limitations

of this sort of rating system are so great that it is best not to use a numerical rating system as the only means for setting priorities. Instead, the rating system is best used as a checklist for systematically evaluating an area and for recording observations in an orderly manner. In addition to recording a numerical rating, the evaluator should record the observations and reasoning that led to the rating of each factor. In this way, the rating system can be a learning tool, instead of an inadequate final answer.

Conclusion

Numerical ranking systems of the kind described above do not seem to be the best means of determining preservation priorities based on the sort of information collected by the Illinois inventory. The Inventory collected a relatively complete set of information about the location and characteristics of natural areas, but using a ranking system based on many, diverse criteria might confuse the priorities. The way to choose the most important sites to preserve is to first determine which areas will most effectively fulfill the goals of preserving natural quality and natural diversity. The most important sites are both the areas that have the rarest significant features and the areas that have the greatest diversity and number of significant features. By listing the features in need of protection, then listing the sites that have these features, the needs can be matched with the resources. An example of this sort of approach is by Dyrness, et al. (1975).

The next stage consists of practical considerations of preservation status, availability, and threats. These criteria are of great importance in planning preservation strategies, but they must be kept separate from evaluating an area on the merits of its natural characteristics. However, it is necessary to recognize which areas are already protected, which ones are most available, and which ones are threatened with immediate destruction. These considerations will help determine the order in which areas are preserved and the amount of immediate effort that should be spent on each area.

Use values such as accessibility and potential for low-intensity recreation are seldom important enough to set priorities for preservation of natural areas. Two areas are rarely so similar that the most important area must be determined by considering such attributes. Protection and management factors are seldom important enough to determine the highest priorities for preservation. Aside from the few areas that may not be practically protected and properly managed, a site that is valuable enough to be listed as a natural area should receive the management efforts needed to protect its significant features.

Selection of the top priority areas is a matter of deciding which sites should be protected first to assure the preservation of the greatest number and diversity of significant features. Initial efforts must be determined by considering preservation status, availability, and threats. The most outstanding areas are usually apparent without recourse to a numerical ranking system, particularly if categories of similar areas (cemetery prairies, geologic areas, aquatic areas, etc.) are treated separately. Beyond the strategy of matching unprotected features with known natural areas, the most important criteria for setting priorities seem to be:

Number and type of significant features
Relative rarity of significant features
Acreage of Grade A and B natural communities
Number and type of exceptional features
Total acreage and number of natural communities

Appendix 28.
PLANT COMMUNITIES

Procedure for Naming Plant Communities

Vegetation may be classified according to plant communities, which are groups of plants that share a common environment. Each community has certain species that are dominant, and each community has plants that are absent from or less common in other communities.

Plant communities were named by the Inventory according to the dominant species. Dominance was measured by basal area in forests and by vegetative cover in other communities. Usually two or three species were used to name the plant community. The species were listed in descending order of dominance. Therefore, a white oak--red oak community is different from a red oak--white oak community.

Species in the same life form were separated by a dash, and species in different life forms were separated by a solidus. Examples:

Big bluestem--Indian grass
Black oak/little bluestem--porcupine grass
Bald cypress/buttonbush/duckweed

Plant Communities Distinguished from Natural Communities

Although vegetation is frequently used to identify, name, and describe natural communities, in the Inventory's classification system, plant communities are not synonymous with natural communities. A plant community is a feature of a natural community. A plant community name is based on vegetation, and a natural community is based on all of the natural features, including vegetation. For example, a name of a natural community is *dry-mesic upland forest*; the corresponding plant community name might be *white oak--red oak--mockernut hickory* or *white oak--black oak*.

The Inventory did not use plant communities to classify natural areas. The plant community names were variable and described the actual

dominants of the vegetation. Natural communities, instead of plant communities, were used to classify natural areas.

Plant communities were named on a stand-by-stand basis, so there were many different combinations of dominant species. For example, red oak was a dominant in 254 stands identified by the Inventory, and there were 91 different plant communities in these stands. Sixty-six of the 91 communities occurred only once. To illustrate the diversity of combinations in which red oak was dominant, the 10 commonest examples are given:

White oak--red oak
White oak--red oak--hickory
Red oak--sugar maple
White oak--red oak--sugar maple
Red oak--sugar maple--basswood
Sugar maple--red oak
Sugar maple--red oak--basswood
White oak--red oak--black oak
Red oak--white ash
Red oak--basswood

Appendix 29.
SPECIES LISTS

Types of Lists

Species lists were used to note the presence or abundance of plants or animals. The following were standard lists:

Amphibians, reptiles, and mammals
Summer birds
Ferns and fern allies
Woody plants

These four lists were completed for each natural area that was visited in the field. Other forms, such as plant checklists for various prairie communities, were also used.

Annotations

The following annotations were entered in the blank beside the name of each species:

Presence.--The presence of a species was noted by a checkmark. Presence gives no indication of *abundance*.

Absolute abundance.--This was the actual number of individuals observed. Absolute abundance was sometimes recorded for species that occurred in very small numbers.

Relative abundance.--Relative abundance was rated according to the following scale:

1. *Rare*: very few individuals observed.
2. *Occasional*: infrequently observed.
3. *Common*: frequently observed.
4. *Abundant*: very frequently observed.
5. *Very abundant*: dominant nearly to the exclusion of other species.

Although ratings were based on relative observations, without counts of individuals or measurements of density, the scale was as precise as

practical for a general field survey. Classes 1 and 5 were reserved for the very extremes.

Distribution.--Some species were limited in distribution, and were annotated with an "L" for "local" or "locally." For instance, L4 means *locally abundant*, and L2 means *occasional and local*. A species was annotated as *local* if it had limited distribution within a natural community, but not simply because it had limited distribution within a natural area.

Native, naturalized, and adventive species.--The number of plant species is a good index of the diversity of a natural area. However, naturalized and adventive species increase with disturbance. These non-native species were annotated as naturalized or adventive so that the species list could not be misinterpreted because of an inflated number of species. The terms *naturalized* and *adventive* were defined as follows: (1) A naturalized species is one that is not native to the natural area, but that is permanently established and reproducing in the area. Most naturalized species are exotics, not native to the Natural Division, or to the state, but some are native to other parts of Illinois. For instance, black locust is native to the Ohio River bluffs in southern Illinois, but it is naturalized in other habitats throughout the state. (2) An adventive species is one that would not naturally occur in the natural area. It has invaded the area, usually in response to disturbance, and probably will not persist. Naturalized species were annotated with an "N," and adventives were noted with an "A."

Appendix 30.

CLASSIFICATION OF NATURAL COMMUNITIES IN ILLINOIS

John White and Michael H. Madany

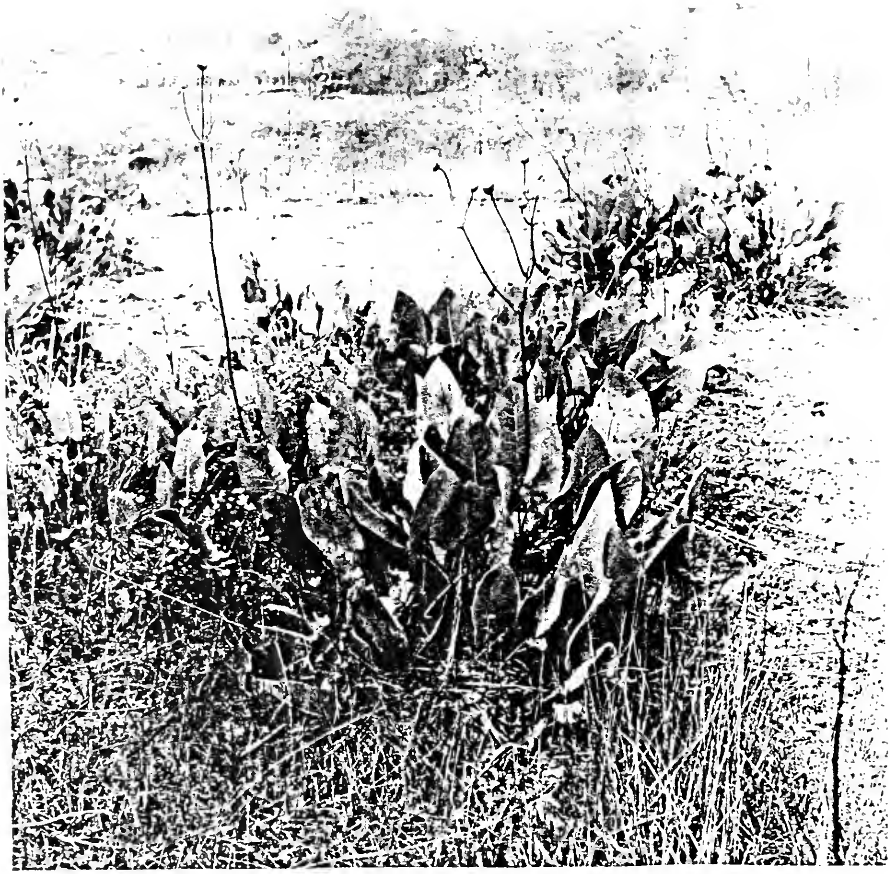

Plate 10. *A calcareous seep community in the Morainal Section of the Northeastern Morainal Division. This natural community is characterized by highly calcareous seeps and spring runs, tufa deposits and open marl flats, and six threatened or endangered plants. The large plant in flower is prairie dock. There are 15 acres of this unusual natural community in Illinois.*

CLASSIFICATION OF NATURAL COMMUNITIES IN ILLINOIS

Introduction

The Illinois Natural Areas Inventory's classification system uses the approach of the *Natural Divisions of Illinois* by Schwegman, et al. (1973), which recognizes regions of the state on the basis of topography, glacial history, bedrock, soil, and distribution of native plants and animals. In the Inventory's classification, the Natural Divisions and Sections are subdivided into community classes and natural communities. The natural communities are classified by considering many natural features and choosing the dominant features to identify, name, and describe the communities. This appendix discusses the classification hierarchy, describes the natural communities, and lists references to publications that describe the communities.

Natural Divisions and Sections

The Natural Divisions of Illinois (Figure 8) was developed by Schwegman, et al. (1973) as a framework for identifying the significant natural features to be included in the Illinois Nature Preserves System. The Inventory's classification further subdivides the 14 Natural Divisions and their Sections into nine community classes and many natural communities. The following summary of the Natural Divisions is adopted from the Illinois Nature Preserves Commission's *Two-year Report 1973-1974* (Illinois Nature Preserves Commission, 1975).

Wisconsin Driftless Division

This is part of an area extending from northwestern Illinois into Wisconsin, Iowa, and Minnesota that apparently escaped Pleistocene glaciation. This division has rugged terrain that had forest, savanna, and prairie. It has the coldest climate in the state. It contains several plants with northern affinities and some possible relicts of the preglacial flora. The division contains lead deposits.

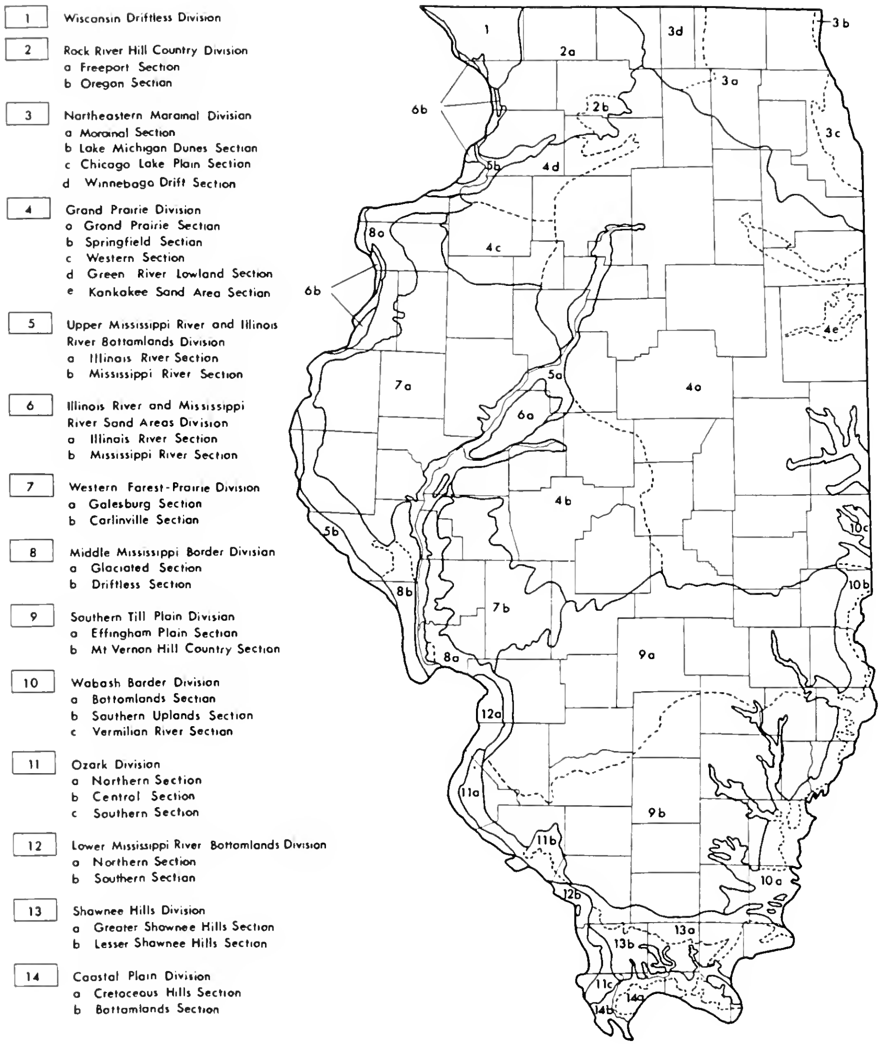

Figure 8. Natural Divisions of Illinois.

Rock River Hill Country Division

The Rock River drains this region of rolling topography. It has a thin mantle of glacial till. Prairie formerly occupied the larger expanses of level uplands, but forest was abundant along the water courses and on the more dissected uplands. Several distinctive plant species occur in this division. The Freeport and Oregon sections are distinguished because of bedrock types and resultant floral differences.

Northeastern Morainal Division

The most recent glaciation in Illinois occurred in this region. Prominent glacial landforms are common features and are responsible for the rough topography over most of the area. Lakebed deposits and natural lakes are also frequent features. Unlike most of Illinois, the soils of this division are derived from glacial drift rather than loess. This division contains distinctive northern and eastern plants, including bog inhabitants. Several species of animals are known in Illinois only from this area. The sections are recognized because of differences in topography, soil, glacial history, flora, and fauna.

Grand Prairie Division

This is a vast plain formerly occupied primarily by tall-grass prairie. The soils were developed from recently deposited loess, lakebed sediments, and outwash. Natural drainage was poor, resulting in many marshes and prairie potholes. Forest bordered the rivers, and there were occasional groves on moraines and glacial hills. The sections of this division are differentiated on the basis of soils, topography, and glacial history.

Upper Mississippi River and Illinois River Bottomlands Division

This encompasses the bottomlands of the Mississippi River above its confluence with the Missouri River as well as the bottomlands of the Illinois River and its major tributaries south of LaSalle. Much of this division was originally forested, but prairie and marsh also occurred. The lower gradient of the Illinois River and its backwater lakes distinguish the Illinois River Section from the Upper Mississippi River Section.

Illinois River and Mississippi River Sand Areas Division

This encompasses the sand areas and dunes in the bottomlands of the Illinois and Mississippi rivers and includes the "perched dunes" atop the bluffs near Hanover in Jo Daviess County. Forest, savanna, and sand prairie are the natural vegetation of this division. Several plant species found here are more typical of the short-grass prairies to the west of Illinois. Several relict western amphibians and reptiles are known only from these sand areas. The two sections are distinguished because of differences in flora and fauna.

Western Forest--Prairie Division

This is a strongly dissected glacial till plain of Illinoian and Kansan age. At the time of settlement, forest was the predominant vegetation, but there was considerable prairie on the level uplands. The prairie soils were developed from loess. The two sections are geographically separated by the Illinois River valley and also have some faunal differences.

Middle Mississippi Border Division

The Middle Mississippi Border Division consists of a relatively narrow band of river bluffs and rugged terrain bordering the Mississippi River floodplain from Rock Island County to St. Clair County and bordering the lower Illinois River. Limestone cliffs are common features. This division is best distinguished from the river bluffs to the north and south of it by the absence of certain plants and animals. The Driftless Section is distinguished from the remainder of the division because it was never glaciated.

Southern Till Plain Division

The Southern Till Plain encompasses most of the area of dissected Illinoian glacial till plain south of the Shelbyville Moraine and the watersheds of the Sangamon River and Macoupin Creek. Both forest and prairie were present at the time of settlement. The soils are relatively infertile and frequently have a claypan or fragipan. Flatwoods are characteristic of the division. The two sections are distinguished because of topographic differences.

Wabash Border Division

This includes the bottomlands of the Wabash River and its major tributaries, the loess-covered uplands bordering the Wabash River, and the ravine forests of the Vermilion River, Little Vermilion River, and Crab Apple Creek. This region has forests with beech, tuliptree, and other trees typical of the forest to the east of Illinois. The Wabash River drainage contains several distinctive fishes. The sections are distinguished by differences in topography, glacial history, flora, and fauna.

Ozark Division

This consists of the Illinois part of the Salem Plateau of the Ozark uplift from St. Clair County southward and includes the glaciated sandstone ravines in Randolph County. The area is mostly forested, but many hill prairies occur in the Northern Section. The division contains many Ozarkian, southern, and southwestern plants and animals that are rare or absent elsewhere in Illinois. The sections are based on differences in bedrock, topography, flora, and fauna.

Lower Mississippi River Bottomlands Division

This includes the Mississippi River and its floodplain from Alton to the Thebes Gorge. The Mississippi River is muddy here due to the silt load contributed by the Missouri River. Its fish fauna contains a distinctive assemblage of silt-tolerant plains species. The Northern Section (including the American Bottom) originally contained prairies, marshes, and forests. The forests of this division contain a greater number of tree species than the forests of the upper Mississippi River, including some southern lowland species.

Shawnee Hills Division

The Shawnee Hills extend across the southern tip of the state from Fountain Bluff on the Mississippi River to the Shawneetown Hills near the mouth of the Wabash River. This unglaciated hill country has a series of east-west sandstone escarpments (the Greater Shawnee Hills) and a series of lower hills underlain by limestone and sandstone known as the Lesser Shawnee Hills. Originally this division was mostly forested, and considerable forest remains to the present time. The Lesser Shawnee Hills has fluorspar deposits.

Coastal Plain Division

This is a region of swampy, forested bottomlands and low clay and gravel hills that is the northernmost extension of the Gulf Coastal Plain Province. Tupelo and bald cypress swamps are distinctive features of this division in Illinois, as are many southern animals and plants. The division encompasses the bottomlands of the Cache, Ohio, and Mississippi rivers, and hills capped by Cretaceous and Tertiary sand, gravel, and clay. It has a relatively mild climate, the warmest in the state. The two sections distinguish between uplands and bottomlands.

Community Classes

A community class is a broad group of natural communities that have important natural features in common. The nine community classes are as follows:

Forest
Prairie
Savanna
Wetland
Lake and Pond
Stream
Primary
Cave
Cultural

Natural Communities

Definition

A *natural community* is a group of organisms that are interrelated with each other and their environment. Although natural communities might be defined at any scale, from biome to microassociation, in this project the term *natural community* is used to identify the smallest units of land or water that can be mapped using Inventory techniques. Important characteristics for identifying natural communities include physiognomy, soil moisture, substrate, soil reaction, species composition, vegetation structure, and topographic position.

Naming natural communities

Each Natural Division and Section has its own distinct set of natural communities, and the name of the Natural Division and Section is

part of the natural community name. For example, a *loess hill prairie of the Northern Section of the Ozark Division* is a community distinct from a *loess hill prairie of the Glaciated Section of the Middle Mississippi Border Division.* For practical reasons, the shortened name, *loess hill prairie*, is used unless it is necessary to distinguish between hill prairies in different Natural Divisions and Sections. The shortened names of natural communities are in Table 38. None of the Natural Divisions or Sections has all of the natural communities in Table 38; and, in fact, some of the natural community names are restricted to a single Section. Community subclasses, which are intermediate in the classification between community classes and natural communities, are also shown in Table 38.

Soil moisture classes

Soil moisture is a basic characteristic for distinguishing natural communities. Many closely related communities are separated on the basis of soil moisture alone. The following seven *soil moisture classes* are adopted with changes from the soil-drainage classes in the USDA *Soil Survey Manual* (Soil Survey Staff, 1953). The classes are based on runoff, permeability, and internal drainage characteristics.

Xeric.--Excessively drained: Water is removed from the soil very rapidly, because sloping bedrock or gravel is at or near the surface. A soil profile is commonly poorly developed or absent. Forest soils are commonly brownish, grayish, or reddish and free of mottling. Prairie soils, if developed, have thin A horizons.

Dry.--Somewhat excessively drained: Water is removed from the soil rapidly. Many of these soils have little horizon differentiation. Forest soils are free of mottling and are brown, yellow, gray, or red. Prairie soils usually have relatively thin A horizons, brownish, yellowish, grayish, or reddish thin B horizons, and no mottling.

Dry-mesic.--Well drained: Water is removed from the soil readily, but not rapidly. Well drained soils are commonly intermediate in texture, although soils of other textural classes may also be well drained. Forest soils are free of mottling (except for fossil gley), and horizons may be brownish, yellowish, grayish, or reddish. They may be mottled

Table 38. Natural community classification.

FOREST

- Upland forest
  - Xeric upland forest
  - Dry upland forest
  - Dry-mesic upland forest
  - Mesic upland forest
  - Wet-mesic upland forest
- Sand forest
  - Dry sand forest
  - Dry-mesic sand forest
  - Mesic sand forest
- Floodplain forest
  - Mesic floodplain forest
  - Wet-mesic floodplain forest
  - Wet floodplain forest
- Flatwoods
  - Northern flatwoods
  - Southern flatwoods
  - Sand flatwoods

PRAIRIE

- Prairie
  - Dry prairie
  - Dry-mesic prairie
  - Mesic prairie
  - Wet-mesic prairie
  - Wet prairie
- Sand prairie
  - Dry sand prairie
  - Dry-mesic sand prairie
  - Mesic sand prairie
  - Wet-mesic sand prairie
  - Wet sand prairie
- Gravel prairie
  - Dry gravel prairie
  - Dry-mesic gravel prairie
  - Mesic gravel prairie
- Dolomite prairie
  - Dry dolomite prairie
  - Dry-mesic dolomite prairie
  - Mesic dolomite prairie
  - Wet-mesic dolomite prairie
  - Wet dolomite prairie
- Hill prairie
  - Loess hill prairie
  - Glacial drift hill prairie
  - Gravel hill prairie
  - Sand hill prairie
- Shrub prairie
  - Shrub prairie

SAVANNA

- Savanna
  - Dry-mesic savanna
  - Mesic savanna
- Sand savanna
  - Dry sand savanna
  - Dry-mesic sand savanna
- Barren
  - Dry barren
  - Dry-mesic barren
  - Mesic barren

WETLAND

- Marsh
  - Marsh
  - Brackish marsh
- Swamp
  - Swamp
  - Shrub swamp
- Bog
  - Graminoid bog
  - Low shrub bog
  - Tall shrub bog
  - Forested bog
- Fen
  - Calcareous floating mat
  - Graminoid fen
  - Low shrub fen
  - Tall shrub fen
  - Forested fen
- Sedge meadow
  - Sedge meadow
- Panne
  - Panne
- Seep & spring
  - Seep
  - Acid gravel seep
  - Calcareous seep
  - Sand seep
  - Spring community

LAKE & POND

- Pond
  - Pond
- Lake
  - Lake
  - Great lake

STREAM

- Creek
  - Low-gradient creek
  - Medium-gradient creek
  - High-gradient creek
- River
  - Low-gradient river
  - Medium-gradient river
  - Major river

PRIMARY

- Glade
  - Sandstone glade
  - Limestone glade
  - Shale glade
- Cliff
  - Sandstone cliff community
  - Limestone cliff community
  - Dolomite cliff community
  - Sandstone overhang community
  - Eroding bluff community
- Lake shore
  - Beach
  - Foredune

CAVE

- Cave
  - Terrestrial cave community
  - Aquatic cave community

CULTURAL

- Cropland
- Pastureland
- Successional field
- Developed land
- Tree plantation
- Artificial pond
- Artificial lake
- Prairie restoration

deep in the C horizon or below depths of several feet. Prairie soils have thick, dark A horizons, reddish, brownish, or yellowish B horizons, and C horizons that may or may not be mottled. Well drained soils commonly retain optimum amounts of moisture for plant growth after rains.

Mesic.--Moderately well drained: Water is removed from the soil somewhat slowly, so that the profile is wet for a small but significant part of the time. Moderately well drained soils commonly have a slowly permeable layer within or immediately beneath the solum, a relatively high water table, additions of water through seepage, or some combination of these conditions. Forest soils have uniform colors in the A and upper B horizons, with mottling in the lower B and in the C horizons. Prairie soils have thick, dark A horizons and yellowish or grayish faintly mottled B horizons.

Wet-mesic.--Imperfectly or somewhat poorly drained: Water is removed from the soil slowly enough to keep it wet for significant periods but not a large part of the time. They commonly have a slowly permeable layer within the profile, a high water table, additions through seepage, or a combination of these conditions. Forest soils are uniformly grayish, brownish, or yellowish in the upper A horizon and commonly have mottlings below 6 to 16 inches in the lower A and in the B and C horizons. Prairie soils have thick, dark A horizons, high in organic matter, and faint evidences of gleying immediately beneath the A horizon.

Wet.--Poorly drained: Water is removed so slowly that the soil remains wet for a large part of the time. The water table is commonly at or near the surface during a considerable part of the year. Poorly drained conditions are due to a high water table, to a slowly permeable layer within the profile, to seepage, or to some combination of these conditions. Forest soils may be light gray from the surface downward, with or without mottlings. Prairie soils commonly have slightly thickened dark-colored surface layers. The large quantities of water that remain in and on the poorly drained soils greatly affect the diversity and structure of the plant community.

Hydric.--Very poorly drained: Water is removed from the soil so slowly that the water table remains at or above the surface the greater

part of the time. Soils of this drainage class usually occupy level or depressed sites and are frequently ponded. Forest soils commonly have dark gray or black surface layers and are light gray, with or without mottlings, in the deeper parts of the profile. Non-forested soils commonly have mucky or peaty surfaces with distinct evidences of gleying.

Communities in combination

Occasionally two or more of the names in Table 38 must be combined to make a new natural community name. This must be done in some aquatic communities and on sites where the soil or topography causes an unusual community. For example, sometimes more than one aquatic community occur as zones in the same body of water. The dominant feature--the water--ties all the zones together, and the whole wetland and water area function as one system. The vegetation zones are often successional stages that will gradually replace each other, or the zones would shift in response to a change in water level. The most common example of aquatic communities in combination is the *shrub swamp/pond* community.

Other natural communities with unusual names result from unusual soil or topographic conditions. For example, a forest on a strongly developed sinkhole plain has dry forest on the narrow divides between the sinks, dry-mesic forest on the slopes, and mesic forest in the bottoms of the sinks. On a normal landscape, three kinds of forest (dry upland forest, dry-mesic upland forest, and mesic upland forest) would be recognized and mapped as separate natural communities. However, in this case, even if it were practical to map the bottom, slope, and rim of each sinkhole as different communities, this would be misleading because the whole sinkhole forest is a single community with a wide range of soil and forest characteristics. This natural community would be named *dry upland forest/dry-mesic upland forest/mesic upland forest.*

A second example occurs in some bottomlands, where slight rises alternate with low, wet areas. The wet areas have silver maple, and the rises have mesophytic species such as black walnut; but the whole area is one natural community with a relatively wide range of soil moisture: *wet floodplain forest/wet-mesic floodplain forest.*

Another combination community is the *dry upland forest/limestone glade* community, which names an unusual area where a forest on a dry limestone slope has many small but distinct glades, which are too small to consider separate communities but are characteristic of the forest community.

Community names should be used in combination only when needed to name an unusual community with a wider range of variability than normal. When community names are used in combination, each name should be given in full, separated by a solidus (/). For example, *wet to wet mesic floodplain forest* or *wet/wet-mesic floodplain forest* should not be substituted for *wet floodplain forest/wet-mesic floodplain forest.*

Plant communities distinguished from natural communities

Although vegetation is frequently used to identify, name, and describe natural communities, in the Inventory's classification plant communities are not synonymous with natural communities. A plant community is a feature of a natural community. A plant community name is based on vegetation, and a natural community is based on all of the natural features, including vegetation. For example, a name of a natural community is *dry-mesic upland forest*; the corresponding plant community name might be *Quercus alba--Quercus rubra--Carya tomentosa.*

There may be more than one plant community in a natural community, because plant communities are successional stages or different end-products of succession within a natural community. In the Inventory's classification, plant community names are variable and descriptive, while natural community names are part of a standard classification. For example, a natural community name for the Bottomlands Section of the Coastal Plain Division is *swamp.* The corresponding plant community names might include (1) *Taxodium distichum--Nyssa aquatica*, (2) *Nyssa aquatica--Taxodium distichum*, (3) *Nyssa aquatica*, and (4) *Taxodium distichum/Cephalanthus occidentalis* communities.

Descriptions of Community Classes and Natural Communities

This section defines each community class and describes the natural communities. The communities are not described in detail, but the

dominant features and means of recognizing the community are given. A general statement about geographic distribution is made for each community. For detailed information about distribution according to Natural Division and Section, see Table 6 in Appendix 1.

Plants that usually dominate the plant community are listed when there are clear dominants. Other plants are listed as "characteristic" of the community: they are not termed "indicators" because few are restricted to one community. The order in which the species are listed implies no relative importance.

Some vertebrates and a few invertebrates that characteristically breed in a particular community are listed. However, because the descriptions of topography, soil, water, and vegetation usually define the community well, animals are listed only when naming the species gives a clearer picture of the community. Few vertebrates are restricted to a single community, so the animals listed are usually ones with specialized habitats and limited distribution in Illinois.

With a few exceptions, nomenclature follows Smith (1978) for fishes, Smith (1961) for amphibians and reptiles, Bohlen (1978) for birds, Jones, et al. (1975) for mammals, and Mohlenbrock (1975) for plants.

Forest

The forest community class includes communities that are dominated by trees, with an average canopy cover of 80% or greater. There are three subclasses: *upland forest* and *floodplain forest* are distinguished by their topographic position, and *flatwoods* are caused by unusual soils. The simple distinction between upland forest and floodplain forest is that upland forests do not normally flood. Forests on terraces are considered upland forests, because (by definition) terraces do not normally flood. Floodplain forests are separated from upland forests because periodic flooding greatly affects the soil, fauna, and flora in floodplains. Flatwoods occur on uplands, bottomlands, and lake plains which intergrade between upland and floodplain, so topographic position is not important in flatwoods communities.

Upland forest.--The upland forest communities are defined by soil moisture class, which ranges from *xeric* to *wet-mesic*.

Xeric upland forest.--The soil is extremely shallow over bedrock or gravel, and canopy trees are often so stunted and low-crowned that there is no understory. Shrubs and small trees may make impenetrable thickets. The groundcover is sparse, and grasses are usually not important. The xeric upland forest intergrades with two other communities: if the soil is deeper and the canopy is more open, a dry barren occurs; and if the soil is shallower or absent and the canopy is more open, a glade occurs.

Distribution: Xeric upland forests are essentially limited to the Shawnee Hills and Cretaceous Hills, although very small stands may occur elsewhere on bedrock or gravel.

Dominant plants: *Quercus marilandica*, *Quercus stellata*, *Vaccinium arboreum*.

Characteristic plants: *Polytrichum* spp., *Vaccinium vacillans*.

Dry upland forest.--The soils are dry, excessively drained, and poorly developed because of steep, exposed slopes or because of bedrock, gravel, or sand at or near the surface. Trees make slow growth, but are not as stunted as in xeric upland forest, and there usually is a well developed understory and groundlayer. If the canopy is open and prairie plants are present, then the community is not a dry upland forest, but is a dry barren: in fact, many dry upland forests of today were most likely maintained as barrens by fire in the past.

Distribution: Dry upland forests occur on steep ridges at the crests of river bluffs and at the edges of escarpments throughout Illinois, but are most common on bedrock outcrops along the Mississippi River and in the Shawnee Hills.

Dominant plants: *Quercus ellipsoidalis*, *Quercus macrocarpa*, *Quercus marilandica*, *Quercus prinus*, *Quercus stellata*, *Quercus velutina*.

Characteristic plants: *Carya glabra*, *Carya texana*, *Dicranum scoparium*, *Leucobryum glaucum*.

Characteristic animals: Ground skink, five-lined skink, fence lizard, summer tanager.

Dry-mesic upland forest.--This community is in an intermediate position along a soil moisture gradient. Trees make good growth, but the canopy is usually more open than in mesic forests.

Distribution: This is the most prevalent forest community in Illinois. It occurs on slopes throughout the state.

Dominant plants: *Quercus alba*, *Quercus rubra*, *Quercus velutina*.

Characteristic plants: *Carya ovata*, *Carya tomentosa*, *Cornus florida*, *Ostrya virginiana*, *Viburnum prunifolium*.

Characteristic animals: Broad-headed skink, white-footed mouse, chipmunk.

Mesic upland forest.--Ideal soil moisture conditions result in a dense overstory and, in undisturbed stands, an understory of shade-tolerant species. Mesic forests occur on north-facing slopes, in ravines, and on level soil with moderately high available moisture.

Distribution: Mesic upland forest may be found throughout the state, but it is most common in hilly regions where slopes are protected from excessive evaporation and from fire.

Dominant plants: *Acer saccharum*, *Fagus grandifolia*, *Quercus rubra*, *Tilia americana*.

Characteristic plants: *Asimina triloba*, *Aesculus glabra*, *Carpinus caroliniana*, *Carya cordiformis*, *Morus rubra*, *Staphylea trifolia*.

Characteristic animals: Tiger salamander, four-toed salamander, wood frog, wood thrush.

Wet-mesic upland forest.--This is an unusual community caused by poor drainage on level topography, along shallow drainageways, and in seepage areas.

Distribution: Small stands of wet-mesic upland forest occur throughout the undissected upland forested regions of the state.

Characteristic plants: *Ulmus americana, Ulmus rubra, Celtis occidentalis, Quercus macrocarpa.*

Floodplain forest.--Floodplain forests are on the floodplain of streams. The communities are determined by the frequency and duration of flooding and by the permeability of the soil. The soil moisture classes range from *mesic* to *wet*: a *hydric* floodplain forest is termed a *swamp*, and is placed in the *aquatic* community class.

Mesic floodplain forest.--This community is in the floodplain, but the soil is moderately well drained, because of either coarse texture or relatively high elevation.

Distribution: Mesic floodplain forest occurs throughout Illinois, although the stands are usually not extensive.

Dominant plants: *Acer saccharum, Quercus alba, Quercus macrocarpa, Ulmus americana, Ulmus rubra, Tilia americana.*

Characteristic plants: *Juglans nigra, Fraxinus americana.*

Characteristic animal: In floodplains, the common mole is generally restricted to mesic soil, especially on natural levees.

Wet-mesic floodplain forest.--This is the most common floodplain forest community. Species diversity is higher in the overstory, but lower in the groundlayer than in mesic floodplain forest.

Distribution: This floodplain community occurs along rivers and creeks throughout the state.

Dominant plants: The forest is usually a mixture of trees, with no clear dominants.

Characteristic plants: *Acer saccharinum, Celtis occidentalis, Liquidambar styraciflua, Quercus falcata* var. *pagodaefolia, Quercus macrocarpa, Quercus palustris, Ulmus americana, Lindera benzoin, Carya laciniosa, Fraxinus pennsylvanica.*

Wet floodplain forest.--Flooding in this community is so frequent or prolonged that the diversity of trees is lowered. The understory and often the overstory are open. Nettles and vines are often prominent.

Distribution: Wet floodplain forest occurs along streams throughout the state. The most extensive tracts are on lake plains and behind natural levees of major rivers.

Dominant plants: Any of the species listed below as characteristic plants may be locally dominant.

Characteristic plants: *Acer saccharinum*, *Populus deltoides*, *Platanus occidentalis*, *Acer rubrum*, *Betula nigra*, *Salix nigra*, *Acer negundo*.

Characteristic animal: Swamp rabbit. Also, many amphibians inhabit wet floodplain forest and the adjacent wet-mesic forest and swamp.

Sand forest.--This community subclass occupies portions of sand deposits where natural firebreaks have greatly reduced burning frequency. The species composition of these communities is similar to that of sand savannas. Post-settlement fire exclusion has probably increased the acreage of sand forest at the expense of sand savanna.

Dry sand forest.--The tops of dunes with the least humus and soil moisture support this community. Trees are often scrubby.

Distribution: This community is limited to sand deposits.

Dominant plant: *Quercus velutina*.

Characteristic plants: *Carya texana*, *Quercus marilandica*.

Dry-mesic sand forest.--Areas with higher soil moisture levels support this forest. Tree size and diversity are correspondingly greater than in dry sand forest.

Distribution: Dry-mesic sand forest may occur with dry sand forest.

Dominant plants: *Quercus alba*, *Quercus velutina*.

Mesic sand forest.--Ravines and slopes that face north or east may support mesic sand forest.

Distribution: This is a rare community, occurring mainly on the slopes of sandy river terraces.

Dominant plants: *Quercus rubra*, *Quercus alba*, *Acer saccharum*.

Flatwoods.--Flatwoods occur on level or nearly level soil that has an impermeable or slowly permeable layer, which causes a shallow, perched water table. The plants and animals must adapt to seasonally wet conditions from the perched water table; and then they must withstand summer dry conditions because the hardpan stops replenishment of soil moisture from capillary action and restricts rooting and burrowing depth. Because soil moisture fluctuates so widely by the season, the moisture class is not in the natural community name. Plants typical of dry and dry-mesic soil grow on slight rises, and depressions contain ephemeral and seasonal ponds. Many flatwoods had savanna vegetation in presettlement times.

Northern flatwoods.--Poorly drained uplands on the Valparaiso Moraine often have this community. Vernal ponds are characteristic. The abundance of sedge meadow and wet prairie species in modern remnants indicates that many northern flatwoods were once savanna.

Distribution: Northern flatwoods are known from the Morainal Section of the Northeastern Morainal Division.

Dominant plants: *Quercus alba*, *Quercus bicolor*, *Quercus ellipsoidalis*, *Ulmus americana*.

Characteristic plants: *Carex muskingumensis*, *Ilex verticillata*, *Habenaria psycodes*.

Characteristic animal: Blue-spotted salamander.

Southern flatwoods.--This community is found on level areas with a well developed hardpan, usually on glacial till of Illinoian age. The unfavorable soil conditions commonly cause stunted trees.

Distribution: This community occurs in the southern part of the state.

Dominant plants: *Quercus stellata*, *Quercus marilandica*, *Quercus palustris*, *Quercus bicolor*, *Quercus alba*, *Quercus falcata* var. *falcata*.

Characteristic plant: *Cinna arundinacea*.

Characteristic animal: Northern crayfish frog.

Sand flatwoods.--This community develops on soils with two distinct layers: 1 meter or more of acid, peaty sand over clay. Where natural firebreaks occur, sand flatwoods occur rather than shrub prairie or wet-mesic sand prairie. In the absence of fire, these prairie communities can succeed to sand flatwoods.

Distribution: Sand flatwoods are restricted to sandy plains in northern Illinois.

Dominant plants: *Quercus palustris*, *Quercus alba*, *Nyssa sylvatica*, *Acer rubrum*.

Characteristic plants: *Ilex verticillata*, *Maianthemum canadense*, *Mitchella repens*, *Osmunda cinnamomea*, *Vaccinium angustifolium*.

Prairie

This community class includes communities dominated by grasses (or, locally, low shrubs) on mineral soil. Trees may be present, but less than 10% of the area has a tree canopy. Six subclasses are recognized: *prairie*, *sand prairie*, *gravel prairie*, *dolomite prairie*, *hill prairie*, and *shrub prairie*.

Prairie.--This subclass is termed simply *prairie*, with no modifier, because it includes the typical, "black-soil" prairies. Soils are deep and fine-textured, usually silt loam or clay loam derived from loess or glacial till, although the prairies may occur on alluvium. Prairie communities in some other subclasses (for example, *mesic sand prairie*) may also have soils with deep, dark A horizons, so the term *black soil* is not applicable solely to this subclass. Soil moisture for these prairies ranges from *dry* to *wet*.

Dry prairie.--This community occupies steep, exposed slopes that are somewhat excessively drained. Grasses are less than 1 meter tall.

Distribution: This community is relatively rare, because the hilly topography necessary for its existence is usually forested. Dry prairie remnants are most prevalent in the hilly prairie regions of northern Illinois.

Dominant plants: *Andropogon scoparius*, *Bouteloua curtipendula*, *Stipa spartea*.

Dry-mesic prairie.--Moisture levels are intermediate between dry and mesic. Grass height approaches that of mesic prairie, and diversity is greater than in dry prairie.

Distribution: This community is distributed generally throughout the prairie regions.

Dominant plants: *Andropogon scoparius*, *Sorghastrum nutans*, *Stipa spartea*.

Characteristic plants: *Amorpha canescens*, *Echinacea pallida*, *Liatris aspera*, *Potentilla arguta*.

Mesic prairie.--Favorable moisture conditions allow for maximum plant species diversity and maximum grass and forb height. The grass layer may be only 1 meter tall if *Sporobolus heterolepis* dominates, but it is sometimes 2 meters tall.

Distribution: Mesic prairie was one of the most widespread and characteristic communities in Illinois.

Dominant plants: *Andropogon gerardi*, *Sorghastrum nutans*, *Sporobolus heterolepis*.

Characteristic plants: *Baptisia leucophaea*, *Dodecatheon meadii*, *Eryngium yuccifolium*, *Liatris pycnostachya*, *Lithospermum canescens*, *Petalostemum candidum*, *Phlox pilosa*, *Silphium laciniatum*, *Silphium terebinthinaceum*.

Characteristic animals: There are many characteristic prairie vertebrates, but probably none are strictly limited to a single natural community. The following species are common in mesic prairie: plains garter snake, prairie kingsnake, dickcissel, grasshopper sparrow, prairie vole, and short-tailed shrew. Others such as the thirteen-lined ground squirrel and upland sandpiper may have been more abundant in drier prairies.

Wet-mesic prairie.--Surface water is present after heavy rains, and the water table is near the surface. Grass composition is a mixture

of mesic prairie and wet prairie species. Wet-mesic prairie is much more diverse than wet prairie and nearly as diverse as mesic prairie.

Distribution: Wet-mesic prairie is best developed on level areas between wet prairie and mesic prairie.

Dominant plants: *Andropogon gerardi*, *Calamagrostis canadensis*, *Panicum virgatum*, *Sorghastrum nutans*, *Spartina pectinata*.

Characteristic plants: *Lysimachia quadriflora*, *Oenothera pilosella*, *Phlox glaberrima*, *Senecio paupercaulus*, *Veronicastrum virginicum*, *Zizia aurea*.

Characteristic animals: Eastern massasauga, bobolink.

Wet prairie.--Surface water is present during the winter and spring, and the soil is nearly always saturated. Plant species diversity is lower than in other prairie communities.

Distribution: Wet prairie was generally distributed throughout the prairie regions of Illinois.

Dominant plants: *Calamagrostis canadensis*, *Carex* spp., *Spartina pectinata*.

Characteristic plants: *Cacalia tuberosa*, *Eupatorium perfoliatum*, *Iris virginica* var. *shrevei*, *Lythrum alatum*, *Sium suave*.

Sand prairie.--Soils in this subclass are coarse-textured: sand, loamy sand, and sandy loam can support sand prairie. However, prairies on sandy loam are considered sand prairies only if they are acidic enough to have characteristic plants. Sand prairies are found on sandy outwash plains, lake plains, and valley trains, and the soil moisture varies from *dry* to *wet*.

Dry sand prairie.--The soil lacks a dark A horizon, and grass is less than 1 meter tall. Dry sand prairies are rather rare because the proper topographic position for dry sand usually also reduces fire severity enough to allow a savanna to develop.

Distribution: This community occurs on the crests of sand dunes.

Dominant plants: *Andropogon scoparius*, *Calamovilfa longifolia*, *Koeleria cristata*, *Stipa spartea.*

Characteristic plants: *Arenaria stricta*, *Artemisia caudata*, *Callirhoe triangulata*, *Monarda punctata*, *Opuntia compressa.*

Dry-mesic sand prairie.--This community has a dark A horizon, unlike the preceding community. The average height of grass and the species diversity approach that of mesic sand prairie.

Distribution: Dry-mesic sand prairie may occur with any other sand prairie communities.

Dominant plants: *Andropogon scoparius*, *Sorghastrum nutans*, *Stipa spartea.*

Characteristic plants: *Aster linariifolius*, *Liatris aspera*, *Solidago speciosa*, *Viola pedata.*

Characteristic animals: Sand prairies have several characteristic animals with western affinities, but probably no species is limited strictly to a single community. Characteristic animals of the sand prairies include the Illinois chorus frog, dusty hognosed snake, bullsnake, lark sparrow, savannah sparrow, vesper sparrow, and plains pocket gopher.

Mesic sand prairie.--This community has a deep A horizon in acid sand. Mosses and low shrubs are common, although the shrubs are not dominant. Characteristic mesic prairie forbs such as *Echinacea pallida*, *Ratibida pinnata*, and *Silphium laciniatum* are rare or absent.

Distribution: Although this community might occur in any of the sand areas of the state, remnants are most common in northeastern Illinois.

Dominant plants: *Andropogon gerardi*, *Andropogon scoparius*, *Sorghastrum nutans.*

Characteristic plants: *Aletris farinosa*, *Aronia melanocarpa*, *Aronia prunifolia*, *Aster umbellatus*, *Calopogon tuberosus*, *Helianthus mollis*, *Parthenium integrifolium*, *Rubus hispidus*, *Scleria*

triglomerata, *Vaccinium angustifolium*.

Wet-mesic sand prairie.--Surface water is present in this community for short periods, and a deep, acid, dark A horizon is present. The mixture of grasses is transitional between mesic sand prairie and wet sand prairie.

Distribution: Small areas of wet-mesic sand prairie are commonly associated with mesic sand prairie.

Dominant plants: *Andropogon gerardi*, *Calamagrostis canadensis*, *Carex* spp., *Sorghastrum nutans*, *Spartina pectinata*.

Characteristic plants: *Osmunda cinnamomea*, *Osmunda regalis*, *Pycnanthemum virginianum* (mentioned to distinguish wet-mesic sand prairie from mesic sand prairie), *Rhexia virginica*, *Viola lanceolata*, *Xyris torta*.

Wet sand prairie.--Surface water is present in this community for as much as one-third of the year. Wet sand prairie is floristically very similar to wet prairie.

Dominant plants: *Calamagrostis canadensis*, *Carex* spp., *Spartina pectinata*, *Thelypteris palustris*.

Gravel prairie.--This subclass includes prairies on gravel or very gravelly soil. The soils are usually calcareous. Because the gravel provides rapid permeability, the soil moisture classes range from *dry* to *mesic*.

Dry gravel prairie.--These prairies are on steep gravel slopes, and the grasses average less than 1 meter in height.

Distribution: Dry gravel prairies occur on kames and eskers in the Northeastern Morainal Division and on the slopes of gravel terraces along major rivers. They may also have occurred on gravelly hills in extreme southern Illinois.

Dominant plants: *Andropogon scoparius*, *Bouteloua curtipendula*.

Characteristic plants: *Anemone patens*, *Arenaria stricta*, *Asclepias lanuginosa*, *Linum sulcatum*, *Lithospermum incisum*, *Ranunculus rhomboides*, *Wulfenia bullii*.

Dry-mesic gravel prairie.--This community has relatively high soil moisture because it occurs on lower slopes. The grass is intermediate in height between dry gravel prairie and mesic gravel prairie.

Distribution: Dry-mesic gravel prairie is associated with dry gravel prairie.

Dominant plants: *Andropogon scoparius*, *Sorghastrum nutans*, *Sporobolus heterolepis*, *Stipa spartea*.

Characteristic plants: *Aster ptarmicoides*, *Psoralea tenuiflora*, *Scutellaria parvula*.

Mesic gravel prairie.--Soil moisture is relatively high because of the low topographic position. The height of the grass and the diversity of plant species approach that of mesic prairie. Calciphilic plants are common because the gravel is usually calcareous.

Distribution: The few known remnants of mesic gravel prairie are on valley train deposits in the Northeastern Morainal Division.

Dominant plants: *Andropogon gerardi*, *Sorghastrum nutans*, *Sporobolus heterolepis*.

Characteristic plants: *Satureja arkansana*, *Valeriana ciliata*.

Dolomite prairie.--Dolomite prairies occur where dolomite is less than 1.5 meters below the surface. Certain common prairie plants are absent because of the shallow soils and high pH. Many other species are restricted to dolomite prairies, but some of these (such as *Desmanthus illinoensis*, *Eleocharis compressa*, and *Satureja arkansana*) are not restricted to specific natural communities. The natural communities range from *dry* to *wet*.

Dry dolomite prairie.--The soil is extremely shallow to negligible in this community, and patches of dolomite pavement are common. The grass is less than 1 meter tall.

Distribution: This community occurs in the Rock River Hill Country and along the lower Des Plaines and Kankakee rivers.

Dominant plants: *Andropogon scoparius*, *Bouteloua curtipendula.*

Characteristic plants: *Blephilia ciliata*, *Kuhnia eupatorioides*, *Muhlenbergia cuspidata*, *Penstemon hirsutus.*

Dry-mesic dolomite prairie.--The soil is slightly deeper over bedrock, and the topographic position is lower than in dry dolomite prairie. Also, grass height is taller and diversity is greater.

Dominant plants: *Andropogon scoparius*, *Sorghastrum nutans*, *Stipa spartea.*

Mesic dolomite prairie.--The soil depth is 15 or more centimeters over dolomite. As bedrock depth decreases, the natural community intergrades with mesic prairie, but deeply rooted forbs such as *Baptisia leucantha*, *Baptisia leucophaea*, *Silphium laciniatum*, and *Silphium terebinthinaceum* are absent from mesic dolomite prairie.

Dominant plants: *Andropogon gerardi*, *Sorghastrum nutans*, *Sporobolus heterolepis.*

Distribution: This and the following dolomite prairies are found along the lower Des Plaines and Kankakee river valleys, but they may also have occurred elsewhere in northern Illinois.

Characteristic plants: *Galium boreale*, *Petalostemum foliosum.*

Wet-mesic dolomite prairie.--The soil depth to bedrock averages 0.3 meter. Surface water is present for short periods throughout the year. Fens can occur in close association with this type where the depth to bedrock becomes deeper along with the proper amount of seepage. Although there is a considerable overlap between a graminoid fen and this community, some characteristic plants are restricted to wet-mesic dolomite prairie.

Dominant plants: *Andropogon scoparius*, *Calamagrostis canadensis*, *Carex* spp., *Deschampsia caespitosa*, *Sorghastrum nutans*, *Spartina pectinata.*

Characteristic plants: *Solidago ohioensis*, *Solidago riddellii.*

Wet dolomite prairie.--The soil is usually quite shallow over bedrock and is frequently saturated, or surface water is present. This is a very rare community even in extensive dolomite areas because depressions usually have a deep enough soil layer to support a sedge meadow at this moisture level.

Dominant plants: *Carex lanuginosa* (?), *Deschampsia caespitosa*, *Spartina pectinata*.

Characteristic plant: *Cacalia tuberosa*.

Hill prairie.--A hill prairie is a prairie opening on a forested slope, caused by a combination of factors which result in droughty, well drained or somewhat excessively drained soil. Hill prairies typically occur on steep, exposed, south to west-facing bluffs. The kind of substrate often contributes to the existence of hill prairies, and periodic fires have maintained many hill prairies. Because the soil moisture class is limited to dry or dry-mesic in hill prairies, the moisture class is not part of the natural community name. Instead, the substrate is the modifier: *loess*, *glacial drift*, *gravel*, or *sand*.

Loess hill prairie.--This community is developed on deep loess, a windblown silt deposit. Loess hill prairies are the largest hill prairies in the state, frequently larger than 1 acre.

Distribution: Loess hill prairies are essentially limited to the Mississippi River and Illinois River bluffs.

Dominant plants: *Andropogon scoparius*, *Bouteloua curtipendula*, *Sorghastrum nutans*.

Characteristic plants: *Asclepias viridiflora*, *Kuhnia eupatorioides*, *Linum sulcatum*, *Lithospermum incisum*, *Penstemon pallidus*, *Psoralea tenuiflora*, *Sisyrinchium campestre*, *Spiranthes magnicamporum*.

Characteristic animal: Six-lined racerunner.

Glacial drift hill prairie.--These hill prairies occur on eroded glacial drift, especially where a river valley cuts through an end moraine and there are many deep, steep-sided tributary ravines.

Distribution: Most of the glacial drift hill prairies are along major rivers in the Grand Prairie Section.

Dominant plants: *Andropogon scoparius*, *Bouteloua curtipendula*, *Sorghastrum nutans*.

Gravel hill prairie.--This community is similar to a dry gravel prairie or dry-mesic gravel prairie, but the hill prairies occur as openings in a forest rather than as part of a continuous prairie.

Distribution: Gravel hill prairies are restricted to northern Illinois and the major river valleys.

Dominant plants: *Andropogon scoparius*, *Bouteloua curtipendula*.

Characteristic plants: *Helianthemum canadense*, *Geum triflorum*.

Sand hill prairie.--These prairies are developed mostly on sand dunes atop river bluffs.

Dominant plants: *Andropogon scoparius*, *Bouteloua curtipendula*, *Bouteloua hirsuta*, *Koeleria cristata*.

Characteristic plants: *Chenopodium leptophyllum*, *Lechea villosa*, *Monarda punctata*, *Plantago purshii*, *Selaginella rupestris*, *Tephrosia virginiana*.

Shrub prairie.--This community subclass is dominated by shrubs and prairie grasses. Only one natural community, on mesic to wet-mesic, sandy soil, is recognized. Another kind of shrub prairie, namely hazel thickets and plum thickets, existed on fine-textured soils in presettlement times, but no natural remnants are known.

Shrub prairie.--The only known natural remnants of shrub prairie are on acid, sandy soil. The community is dominated by a wide variety of shrubs and grasses, and there is a nearly continuous groundlayer of mosses. This community intergrades with mesic sand prairie and wet-mesic sand prairie.

Distribution: This community is limited to northern Illinois, and it is most prevalent in the Kankakee Sand Area and the Chicago Lake Plain.

Dominant plants: *Andropogon gerardi*, *Andropogon scoparius*, *Gaylussacia baccata*, *Polytrichum commune*, *Rubus hispidus*, *Rubus setosus*, *Sorghastrum nutans*, *Spirea tomentosa* var. *rosea*, *Vaccinium angustifolium*.

Characteristic plants: *Aronia melanocarpa*, *Aronia prunifolia*, *Habenaria flava*, *Sphagnum* spp., *Viola lanceolata*, *Viola primulifolia*.

Savanna

Savannas are communities with a grassy groundcover and an average tree canopy cover less than 80% but greater than 10%. A savanna may have shrubby areas, and the tree canopy may locally be greater or less than the above limits. Savannas have soils that are transitional between forest and prairie, and they have distinctive plants and animals. These communities were maintained by fire in presettlement times. They were among the most widespread and characteristic communities in Illinois, but few high quality stands remain. Most remnants have obviously been changed. The least-disturbed remnants are on sandy land that still is frequently burned, and on the very driest slopes where woody encroachment has been slowest. Three savanna subclasses can be named in Illinois: *savanna*, *sand savanna*, and *barren*. Individual savanna communities are distinguished by soil moisture class.

Savanna.--The typical savanna community subclass occupies fine-textured soil on till plains and lowlands. Savannas occurred as an ecotonal belt along streamside forests, as "islands" in prairie or forest, and on extensive areas of hilly land. Two natural communities based on soil moisture are recognized.

Dry-mesic savanna.--In this community, soil moisture levels are analogous to dry-mesic upland forest. Grass height and the composition of the herbaceous vegetation are analogous to that of dry-mesic prairie.

Distribution: This community occurred throughout the prairie regions of Illinois.

Dominant plants: *Quercus alba*, *Quercus macrocarpa*, *Quercus stellata*, *Quercus velutina*, *Andropogon scoparius*, *Sorghastrum nutans*, *Stipa spartea*.

Characteristic plants: *Corylus americana*, *Parthenium integrifolium*, *Smilax lasioneura*, *Silene stellata*.

Characteristic animals: Cavity-nesting birds such as the eastern bluebird, red-headed woodpecker, and common flicker are characteristic of savannas. Other savanna inhabitants include the field sparrow, white-eyed vireo, indigo bunting, deer mouse, and fox squirrel.

Mesic savanna.--The moisture level in mesic savannas is the same as in mesic prairie, and the herbaceous vegetation is similar to mesic prairie. This community is found at the base of moraine ridges and (rarely) as islands in wetland vegetation.

Dominant plants: *Quercus alba*, *Quercus macrocarpa*, *Andropogon gerardi*, *Andropogon scoparius*, *Sorghastrum nutans*.

Characteristic plants: *Heliopsis helianthoides* (?), *Lathyrus venosus*, *Zizia aurea*.

Sand savanna.--The soils are very sandy, with little humus. Sand savannas are associated with dune and swale topography, either dunes or beach ridges. The undulating topography presumably limited the severity of fires and allowed a savanna to develop instead of a sand prairie. The herbaceous vegetation of a sand savanna is quite similar to that of sand prairies. Two sand savanna communities are distinguished by soil moisture.

Dry sand savanna.--The crests of the highest dunes support this community. There is little or no A horizon. Grasses are shorter than 1 meter, and plant species diversity is low.

Distribution: This community occurs in the major sand regions of Illinois.

Dominant plants: *Andropogon scoparius*, *Calamovilfa longifolia*, *Carex pensylvanica*, *Koeleria cristata*, *Quercus velutina*, *Stipa spartea*.

Characteristic plants: *Commelina erecta*, *Monarda punctata*, *Phlox bifida*.

Dry-mesic sand savanna.--There is some development of an A horizon in this community, because it has a lower topographic position than the preceding community or because it occurs on north-facing or east-facing dune slopes.

Distribution: Dry-mesic sand savanna may occur in the same area as dry sand savanna.

Dominant plants: *Andropogon scoparius*, *Carex pensylvanica*, *Quercus velutina*, *Sorghastrum nutans*, *Stipa spartea*.

Characteristic plants: *Aster linariifolius*, *Ceanothus americanus*, *Gerardia pedicularia*, *Lupinus perennis*, *Salix humilis*, *Vaccinium angustifolium*.

Characteristic animals: Sand prairie species also inhabit the savannas. The Illinois mud turtle lives in a shallow pond in a sand savanna, and the western kingbird nests in this community.

Barren.--This term is applied to local inclusions of prairie flora, mixed with forest, in forested land mainly in southern and western Illinois and along major rivers. The term *barren* is ambiguous because it has been applied variously to treeless areas, shrubby areas, and forested areas with grassy groundcover. This ambiguity lends itself well to the kind of remnants that the Inventory termed *barrens*, because this community subclass includes a diversity of former communities, some of which have been heavily disturbed and have changed greatly since settlement. Three communities are separated in soil moisture classes.

Dry barren.--The soil is shallow, over bedrock or on dry, exposed slopes. The tree layer has stunted xerophytic oaks, and the sparse grass layer is shorter than 1 meter.

Distribution: Dry barrens occur in the Shawnee Hills and in widely separated areas along major stream valleys.

Dominant plants: *Andropogon scoparius*, *Carex pensylvanica*, *Danthonia spicata*, *Koeleria cristata*, *Quercus marilandica*, *Quercus stellata*, *Quercus velutina*, *Vaccinium arboreum*.

Characteristic plants: *Carya texana*, *Clitoria mariana*, *Liatris squarrosa*.

Dry-mesic barren.--The soil depth is greater and the moisture level is higher than in the preceding community, resulting in taller tree and grass layers.

Distribution: Dry-mesic barrens occur in the Shawnee Hills, in widely separated areas along major river valleys, and on ravine crests.

Dominant plants: *Andropogon scoparius*, *Danthonia spicata*, *Quercus alba*, *Quercus falcata* var. *falcata*, *Quercus velutina*, *Sorghastrum nutans*.

Characteristic plants: *Commandra richardsiana*, *Helianthus mollis*, *Lechea intermedia*, *Parthenium integrifolium*.

Mesic barren.--This is an unusual community, and few remnants exist because the soils usually support forest vegetation.

Distribution: The only known remnants are in the Cretaceous Hills.

Dominant plants: *Andropogon gerardi*, *Andropogon scoparius*, *Quercus alba* (?), *Quercus falcata* var. *falcata* (?), *Sorghastrum nutans*.

Wetland

The wetland community class includes natural communities that are flooded or have hydric soils and that have a vegetative cover. The subclasses (*marsh*, *swamp*, *bog*, *fen*, *sedge meadow*, *panne*, and *seep and spring*) are recognized mainly by differences in the vegetation.

Marsh.--Tall graminoid plants dominate marsh communities, which have water near or above the surface for most of the year. Soils may be peat, muck, or mineral. Two natural communities are distinguished.

Marsh.--This class includes fresh-water communities in glacial potholes, in river valleys, and on lake plains. Marshes have a wide variety of plant communities. In general, the deeper the water, the lower the plant species diversity. Fluctuations in water levels, fire frequency, and muskrat population cycles are also important in determining species composition.

Distribution: Once very widespread, natural marshes are now common only in the Northeastern Morainal Division. Disturbed remnants of larger marshes exist in the Grand Prairie, and marshes fringe the navigation pools on the Illinois River.

Dominant plants: *Carex lacustris*, *Decodon verticillatus*, *Phragmites communis*, *Polygonum amphibium*, *Polygonum coccineum*, *Scirpus fluviatilis*, *Scirpus validus*, *Typha angustifolia*, *Typha latifolia*.

Characteristic plants: *Alisma* spp., *Boltonia latisquama*, *Proserpinaca palustris*, *Sagittaria latifolia*, *Scutellaria epilobiifolia*.

Characteristic animals: Muskrat, red-winged blackbird, yellow-headed blackbird, rails, bitterns, and many waterfowl.

Brackish marsh.--This rare natural community is restricted to salty seepage areas.

Distribution: Brackish marshes are known along a short segment of river bluff upstream from Starved Rock.

Dominant plant: *Spartina pectinata*.

Characteristic plants: *Atriplex hastata*, *Hibiscus palustris*, *Scirpus paludosus*.

Swamp.--A swamp is a wetland dominated by woody plants. Two communities are recognized on the basis of vegetation structure.

Swamp.--A true swamp is a forested, permanent or semi-permanent body of water.

Distribution: Swamps are limited to extreme southern Illinois, because only southern tree species (except for *Larix laricina*) can live in permanent bodies of water.

Dominant plants: *Nyssa aquatica*, *Taxodium distichum*, *Cephalanthus occidentalis*.

Characteristic plants: *Salix nigra*, *Fraxinus tomentosa*, *Rosa palustris*, *Itea virginica*.

Characteristic animals: Mole salamander, green treefrog, bird-voiced treefrog, bantam sunfish, prothonotary warbler, wood duck.

Shrub swamp.--A shrub swamp has at least 50% coverage by shrubs; a body of water with less coverage is termed a *pond*. A shrub swamp has less than 20% coverage by trees, or else it is classified simply as a swamp. Shrub swamps are often associated with ponds in wet floodplain forest. Occasionally, shrub swamps occur in glacial potholes, where they grade into the tall shrub bog community.

Distribution: Shrub swamps are generally distributed throughout the state.

Dominant plants: *Cephalanthus occidentalis*, *Cornus stolonifera*, *Salix discolor*, *Salix interior*, *Alnus rugosa*.

Bog.--Low-nutrient, acid (at least in the uppermost layer) peat deposits support a variety of bog communities. Bogs are nearly always in glacial depressions, and drainage is usually restricted. Bogs are often characterized by a "moat" along the periphery. This zone of open water, marsh, sedge meadow, or fen may be caused by a combination of fire and calcareous seepage from the mineral-rich till. A layer of *Sphagnum* (usually associated with *Polytrichum*) characterizes nearly all bog communities. There are four natural communities in this community class, all restricted now to the Northeastern Morainal Division.

Graminoid bog.--This community nearly always is floating. Sedges are codominant with *Sphagnum*, and low shrubs are uncommon. This community is closest to open water and can be viewed as first in successional order.

Dominant plants: *Carex hystricina* (?), *Carex lasiocarpa*, *Carex haydenii*, *Carex* spp., *Polytrichum commune* (?), *Sphagnum recurvum*, *Sphagnum* spp.

Characteristic plants: *Drosera rotundifolia*, *Menyanthes trifoliata*, *Sarracenia purpurea*.

Low shrub bog.--This community may or may not be floating. Two conspicuous strata are present: one of low shrubs and a moss layer of *Sphagnum* and *Polytrichum*.

Dominant plants: *Betula pumila*, *Chamaedaphne calyculata*, *Polytrichum commune*, *Sphagnum* spp.

Characteristic plants: *Eriophorum virginicum*, *Vaccinium macrocarpon*.

Forested bog.--This community exists on fairly well consolidated peat. Hummocks (which tend to be more acid) and small, wet depressions are characteristic. Two distinct layers are significant: the tree layer (greater than 20% coverage) and a stratum of tall shrubs. This category includes both forested bogs with a markedly acid upper peat horizon and those with only scattered areas of acidity. The latter have been termed "half-bogs" or "forested fens" by some authorities.

Dominant plants: *Ilex verticillata*, *Larix laricina*, *Rhamnus frangula* (alien), *Rhus vernix*.

Characteristic plants: *Cypripedium acaule*, *Lycopodium lucidulum*, *Osmunda cinnamomea*, *Trientalis borealis*, *Vaccinium corymbosum*.

Tall shrub bog.--This community is regarded as the climax in Illinois bog succession, and it occupies the most consolidated peat. Its major difference from the preceding community is the lack of a tree layer.

Dominant plants: *Cornus stolonifera*, *Ilex verticillata*, *Rhamnus frangula* (alien), *Rhus vernix*.

Fen.--Peat with calcareous seepage is necessary for all fen communities. Most fen communities tend to have a rather pronounced slope. They are most closely correlated with calcareous (especially gravelly) moraines and occur in both lake basins and stream valleys. Fens are often in association with strongly calcareous spring runs as well as such natural communities as calcareous seeps, sedge meadows, and marshes. The five fen communities are restricted to the northern third of Illinois, extending down the Illinois River valley.

Calcareous floating mat.--This community always has a floating layer of sedge peat. This peat is quite calcareous, and *Sphagnum* is generally absent. A moderately tall layer of sedges and grasses dominates the mat.

Distribution: The only remaining examples of this community are in the extreme northern part of the Northeastern Morainal Division.

Dominant species: *Calamagrostis canadensis*, *Carex aquatilis* var. *elatior*, *Carex lasiocarpa*, *Decodon verticillatus*.

Characteristic plants: *Cardamine pratensis* var. *palustris*, *Menyanthes trifoliata*, *Potentilla palustris*, *Salix candida*, *Salix pedicellaris*.

Graminoid fen.--Sloping peat is either at the edge of a moraine or, more rarely, is a raised island in a marsh or sedge meadow. In the latter case, this has been attributed to upwelling of groundwater. Dominants are either mesic prairie grasses in the most elevated peat or sod-forming sedges (but never tussock-forming sedges). Although the peat is quite elevated, it resists decay due to the high level of calcium and magnesium carbonate. Diversity is quite high since both mesic prairie and wet prairie species can occur side by side in addition to numerous calciphilic and hydrophytic species.

Dominant plants: *Andropogon gerardi*, *Andropogon scoparius*, *Carex haydenii*, *Carex sterilis*, *Sorghastrum nutans*, *Sporobolus heterolepis*.

Characteristic plants: *Carex hystricina*, *Liatris spicata*, *Lobelia kalmii*, *Lysimachia quadriflora*, *Muhlenbergia glomerata*, *Parnassia glauca*, *Solidago ohioensis*.

Low shrub fen.--The site is usually identical to the graminoid fen, with one important exception: large poorly vegetated seepage areas with spring runs serve as fire breaks to permit dominance by low shrubs.

Dominant plants: *Carex* spp., *Carex sterilis*, *Potentilla fruticosa*.

Tall shrub fen.--Site conditions are similar to the low shrub fen. Dominants are tall shrubs with a mixture of fen and seep herbs in the groundlayer.

Distribution: Apparently, this community is restricted to the edge of Upper Peoria Lake.

Dominant plants: *Cornus stolonifera*, *Rhus vernix*, *Salix discolor*.

Characteristic plants: *Cypripedium reginae*, *Filipendula rubra*, *Solidago patula*.

Forested fen.--This community is on relatively steep slopes in peat, and the tree cover is greater than 20%. Natural fire breaks (as in shrub fens) are probably necessary for development of this community.

Dominant plants: *Fraxinus nigra*, *Larix laricina*, *Thuja occidentalis*.

Characteristic plants: *Conioselinum chinense*, *Geum rivale*, *Habenaria hyperborea*, *Symplocarpus foetidus*.

Sedge meadow.--A sedge meadow is a wetland dominated by sedges (*Carex*) on peat, muck, or wet sand. The sedge meadow is remarkably homogeneous in composition and structure.

Sedge meadow.--The soil moisture level is analogous to that of wet prairie, and there is some degree of floristic overlap between the two communities. *Carex stricta* is the major dominant.

Dominant plants: *Carex lacustris*, *Calamagrostis canadensis*, *Carex lasiocarpa*, *Carex stricta*.

Characteristic plants: *Aster lucidulus*, *Chelone glabra*, *Epilobium leptophyllum*, *Eupatorium maculatum*, *Triadenum virginicum*.

Panne.--This subclass (with one natural community) is restricted to wet and wet-mesic swales in calcareous sand within 1 mile of Lake Michigan.

Panne.--This community has considerable floristic overlap with the graminoid fen and the calcareous seep. Competition is not as intense as in fens, because panne's sod is not dense.

Dominant plants: *Calamagrostis canadensis*, *Carex* spp., *Cladium mariscoides*, *Juncus balticus* var. *littoralis*, *Potentilla fruticosa*.

Characteristic plants: *Carex viridula*, *Eleocharis olivacea*, *Linum medium* var. *texanum*, *Triglochin maritima*, *Triglochin palustris*, *Utricularia cornuta*.

Seep and spring.--This community subclass occurs where groundwater flows to the surface. A *seep* is an area with saturated soil caused by water flowing to the surface in a diffuse rather than concentrated flow. Seeps may have local areas of concentrated flow, and the water usually collects in spring runs. Seeps are usually smaller than 0.1 acre, and are most common along the lower slopes of glacial moraines, ravines, and terraces. A *spring*, as opposed to a *seep*, has a concentrated flow of groundwater from a definite orifice. The various communities in this subclass are separated on the basis of substrate and water characteristics.

Seep.--This is the typical, common seep community with circumneutral water. A tree cover is often present.

Distribution: Seeps occur throughout the state, although they are commonly too small to recognize as significant communities.

Dominant plants: *Carex* spp., *Cornus alternifolia*, *Fraxinus nigra*, *Symplocarpus foetidus*, *Glyceria striata*, *Impatiens biflora*, *Pilea pumila*.

Characteristic plants: *Angelica atropurpurea*, *Caltha palustris*, *Conocephalus conicum*, *Pedicularis lanceolata*, *Chelone glabra*, *Solidago patula*, *Epilobium coloratum*.

Acid gravel seep.--This community has muck or peat deposits and a low pH, caused by water flowing through gravel.

Distribution: Acid gravel seeps are restricted to a small area of the Cretaceous Hills Section.

Characteristic plants: *Athyrium filix-femina*, *Carex incomperta*, *Osmunda cinnamomea*, *Osmunda regalis*, *Sphagnum* spp., *Bartonia paniculata*, *Woodwardia areolata*.

Calcareous seep.--Groundwater issuing forth is so highly calcareous that tufa deposits form. Many typical seeps are somewhat calcareous; but the distinction is drawn when tufa is present, forest cover is absent, and peat deposits (usually) adjoin the seep. Calcareous seeps usually occur in close association with various fen communities.

There is some floristic overlap with fens as well as with the panne.

Distribution: Calcareous seeps are nearly restricted to the Wisconsinan till plain.

Characteristic plants: *Cladium mariscoides*, *Deschampsia caespitosa*, *Eleocharis rostellata*, *Juncus brachycephalus*, *Potentilla fruticosa*, *Rhynchospora capillacea*, *Rhynchospora alba*, *Scirpus caespitosus*, *Scleria verticillata*, *Silphium terebinthinaceum*, *Tofieldia glutinosa*, *Triglochin palustris*.

Sand seep.--The usually acid seepage water flows through sand, usually at the edge of dune or beach ridges. Some muck deposits can accumulate.

Distribution: This community is best developed in the Chicago Lake Plain and Kankakee Sand Area.

Characteristic plants: *Athyrium filix-femina*, *Glyceria striata*, *Osmunda cinnamomea*, *Osmunda regalis*, *Physocarpus opulifolius*, *Symplocarpus foetidus*, *Dryopteris spinulosa*.

Spring community.--Occasionally, large springs flow across such a broad area that the spring merits recognition as a distinct natural community. (Usually springs are simply considered to be features of larger communities.) Vascular plant communities are not well developed in this natural community.

Distribution: Large spring natural communities are essentially limited to the Ozark Hills and Shawnee Hills Division.

Characteristic plants: *Chara* spp., *Nasturtium officinale* (alien).

Lake and Pond

Lakes and ponds are bodies of open, standing water. They are separated from wetlands by the general lack of emergent woody or graminoid vegetation. There are two subclasses: *pond* and *lake*.

Pond.--Only one pond natural community is recognized. All ponds in Illinois, even those associated with bogs, appear to be eutrophic, not dystrophic or oligotrophic.

Pond.--A pond is a small, still body of water, usually shallow enough to allow rooted aquatic plants across most of it. A pond is given natural community status only if it is *permanent* or *semi-permanent*, not seasonal or ephemeral.

Distribution: Almost all bodies of water in Illinois, including many backwater sloughs connected to major rivers, are classified as pond communities rather than lakes.

Characteristic plants: *Nuphar advena*, *Nymphaea tuberosa*, *Potamogeton* spp., *Spirodela* spp., *Lemna* spp., *Polygonum* spp.

Characteristic animals: Bullfrog, mud minnow, golden shiner, black bullhead, pugnose minnow, bantam sunfish, pigmy sunfish, slough darter.

Lake.--The distinction between a *lake* and a *pond* is difficult to make, but it can be made with natural characteristics rather than by size alone. A lake has an area of deep water sufficiently large to produce somewhere on its periphery a barren, wave-swept shore. A barren, wave-swept shore is distinguished by an absence of attached aquatic plants, an absence of finely divided organic matter on the bottom, an absence of air-breathing invertebrates, and the presence of only those invertebrates that maintain their position by burrowing. Thermal stratification is usually present in a lake, but not always present in ponds. Two lake natural communities are recognized: *lake* and *great lake*.

Lake.--The natural lakes in Illinois can all be classified as eutrophic.

Distribution: Lakes formerly occurred on upland plains and in bottomlands throughout Illinois, but most have been drained. Backwater lakes are still present along the Illinois and Mississippi rivers, but their water levels have been altered. Most of the natural lakes remaining are in the Northeastern Morainal Division.

Characteristic animals: Blackchin shiner, yellow perch, blacknose shiner, banded killifish.

Great lake.--This is Lake Michigan, a deep, naturally oligotrophic body of water, which has suffered some eutrophication along the Illinois shore.

Characteristic animals: Bloater, alewife (alien), lake chub, cisco, ninespine stickleback, longnose dace, longnose sucker.

Stream

Streams are flowing waters. Streams must be permanent, not intermittent or ephemeral (flowing only after rains) to be considered as distinct natural communities instead of features of another community. Although stream communities intergrade, two community classes are recognized on the basis of size: *creek* and *river*.

Creek.--A creek is defined as a perennial stream with a watershed smaller than 200 square miles (520 square kilometers). Three creek communities are identified on the basis of their gradients.

High-gradient creek.--This is a creek with a gradient of 10 or more feet per mile (1.9 or more meters per kilometer). Riffles, pools, and sand and gravel beds are characteristic of high-gradient creeks.

Distribution: Headwater streams throughout much of Illinois are classified as high-gradient creeks.

Characteristic plant: *Dianthera americana*.

Characteristic animals: Banded sculpin, blackspotted topminnow, common stoneroller, southern redbelly dace, pickerel frog.

Medium-gradient creek.--A medium-gradient creek has a fall of between 1 and 10 feet per mile (0.2 to 1.9 meters per kilometer).

Distribution: Medium-gradient creeks are generally distributed throughout Illinois.

Characteristic animals: Longear sunfish, hornyhead chub, red shiner, suckermouth minnow.

Low-gradient creek.--A low-gradient creek has a gradient of less than 1 foot per mile (0.2 meters per kilometer). The current is sluggish, there are no riffles, and the sediments are silt and organic matter.

Distribution: This community is characteristic of prairie uplands and the bottomlands of major rivers.

Characteristic animals: Creek chubsucker, yellow bullhead, slough darter, creek chub, redfin shiner.

River.--A river is a stream with a watershed of 200 square miles (520 square kilometers) or more. Three river communities (recognized by size and gradient) are identified.

Low-gradient river.--The gradient of this community is less than 1 foot per mile (0.2 meters per kilometer). The channel is meandering, and the current is sluggish. There may be sand bars, but the sediments are mainly silt.

Distribution: Low-gradient rivers occur throughout the state. Examples include the Big Muddy, Sangamon, and Green rivers.

Characteristic animals: Flathead catfish, eastern spiny softshell.

Medium-gradient river.--The gradient of this community is between 1 foot and 10 feet per mile (0.2 to 1.9 meters per kilometer). Gravel riffles and raceways and sand bars are characteristic of this community.

Distribution: Medium-gradient rivers are probably somewhat less common than low-gradient rivers. Examples include sections of the Rock, Kankakee, and Mackinaw rivers.

Characteristic animals: River redhorse, largescale stoneroller, northern hog sucker, channel catfish, stonecat, smallmouth bass, smooth softshell.

Major river.--A major river is one with a very wide and deep channel and a very large flow. All of the major rivers in Illinois are low-gradient streams.

Distribution: The major rivers in Illinois are the Mississippi, Illinois, Ohio, and Wabash rivers.

Characteristic animals: Paddlefish, shovelnose sturgeon, river shiner, blue catfish, bigmouth buffalo, black tern.

Primary

This community class includes a wide variety of natural communities that share the following characteristics: (1) Soil is thin or absent, and the parent material is at or near the surface. (2) The communities are maintained indefinitely at an early stage of succession by the substrate or by natural disturbance. The natural communities in this community class can be loosely grouped as follows: *glade*, *cliff*, and *lake shore*.

Glade.--A glade is an opening in the forest, caused by bedrock at or near the surface and (usually) a steep southern or western exposure. A glade is usually a mosaic of stunted trees, shrubs, patches of herbaceous vegetation, and open areas with little or no vegetation. The soil is thin or absent, and the site is either dry or xeric, so the soil moisture class is not part of the natural community name. Glades are defined by their rock type: *sandstone*, *limestone*, or *shale*.

Sandstone glade.--This community occupies the tops of cliffs and the steep upper slopes of south-facing escarpments. Sandstone crops out, and soil is poorly developed. Trees are stunted and open grown, and shrubs are common. The overstory usually covers less than half of the area, and herbaceous vegetation is sparse. Sandstone glades often intergrade with a bordering zone of dry upland forest.

Distribution: Sandstone glades are essentially limited to the Shawnee Hills.

Dominant plants: *Andropogon scoparius*, *Juniperus virginiana*, *Quercus marilandica*, *Quercus stellata*, *Ulmus alata*, *Vaccinium arboreum*.

Characteristic plants: *Cheilanthes lanosa*, *Croton monanthogynus*, *Danthonia spicata*, *Gerardia tenuifolia*, *Hypericum gentianoides*, *Sedum pulchellum*, *Sporobolus vaginiflorus*, *Talinum parviflorum*, *Opuntia compressa*.

Characteristic animals: Fence lizard, six-lined racerunner.

Limestone glade.--These glades are found on steep south and west-facing spurs and bluffs of limestone. The soil is deeper than in a sandstone glade, but it is rocky and usually clayey. Both the pH

and nutrient levels are higher, resulting in a fairly diverse community. Limestone glades sometimes occur with loess hill prairies, and there is a strong floristic overlap with hill prairies. The best distinguishing features are the presence of limestone outcrops, shallow soil, and (usually) relatively many trees, shrubs, and vines.

Distribution: Limestone glades occur in the Shawnee Hills Division and on the Mississippi River and Illinois River bluffs.

Dominant plants: *Andropogon scoparius*, *Bouteloua curtipendula*, *Sorghastrum nutans*.

Characteristic plants: *Agave virginica*, *Aster patens*, *Cacalia tuberosa*, *Eryngium yuccifolium*, *Juniperus virginiana*, *Kuhnia eupatorioides*, *Lithospermum canescens*, *Physostegia virginiana*, *Quercus muhlenbergii*, *Silphium terebinthinaceum*, *Smilax bona-nox*, *Echinacea pallida*.

Shale glade.--Shale does not normally form rocky slopes; but, in a few square miles of Illinois, a series of steep ridges is formed in thick shale outcrops. Natural openings occur on exposed slopes, and these are termed shale glades.

Distribution: Shale glades are essentially limited to a small part of the Southern Section of the Ozark Division.

Dominant plants: *Quercus marilandica*, *Quercus stellata*, *Juniperus virginiana*, *Andropogon scoparius*.

Characteristic plant: *Asclepias tuberosa*.

Cliff.--Vertical exposures of resistant bedrock as well as unconsolidated materials are included in this subclass. Soils are generally nonexistent, and communities have been delimited on the basis of rock type. Aspect and degree of shading are also significant, but have not been used to separate communities due to practical considerations.

Sandstone cliff community.--Aspect and specific rock characteristics are important determinants of species composition and abundance. In general, north and east-facing slopes support the most vegetation. Another important factor is the degree of shading from the adjacent forest.

Distribution: Sandstone cliffs large enough to be recognized as distinct communities are abundant in the Shawnee Hills Division, and are generally scattered throughout the rest of the state.

Characteristic plants: *Dryopteris marginalis*, *Heuchera parviflora*, *Cheilanthes lanosa*.

Characteristic animals: Turkey vultures and black vultures nest in protected sites on sandstone cliffs.

Limestone cliff community.--The general discussion for sandstone cliffs also applies to limestone cliffs. The main differences between the two communities is the usually lesser resistance to weathering and the higher pH of limestone cliffs.

Distribution: Limestone cliffs occur throughout Illinois where bedrock crops out, but they are most prominent along the Illinois and Mississippi rivers.

Characteristic plants: *Cystopteris bulbifera*, *Pellaea atropurpurea*, *Pellaea glabella*.

Dolomite cliff community.--This community may be essentially the same as the limestone cliff community.

Distribution: Dolomite cliffs are mostly limited to stream valleys in the northern part of the state.

Characteristic plants: *Cystopteris bulbifera*, *Physocarpus opulifolius*, *Aralia racemosa*, *Campanula rotundifolia*, *Pelleae glabella*.

Characteristic animal: Cliff swallow.

Sandstone overhang.--This is a small but distinct natural community which occurs when a sandstone cliff forms a shelter. The soil beneath the overhang may consist of sandy residuum or unweathered loess. Light intensities are low, and soil moisture ranges from *dry* to *wet*.

Distribution: Sandstone overhangs large enough to consider as distinct natural communities are common in the Shawnee Hills, but are rare in the rest of the state.

Characteristic plants: *Trichomanes boschianum*, *Dodecatheon frenchii*.

Characteristic animals: Eastern phoebe, antlion larvae (Myrmeleontidae).

Eroding bluff community.--This community consists of vertical exposures of eroded unconsolidated material (for example, glacial drift) or weak rock (such as shale). The steep slope is maintained by stream or lake erosion, and the biotic community is poorly developed because of continual slumping.

Distribution: Eroding bluffs are especially common along major rivers in the glaciated part of Illinois.

Characteristic plants: *Danthonia spicata*, *Solidago nemoralis*, *Taenidia integerrima*, *Melilotus alba* (alien).

Characteristic animals: Kingfisher, bank swallow, rough-winged swallow.

Lake shore.--Lake-deposited sands form the substrate for this community subclass. Depending on the age of the deposit and the successional development, two communities are formed. These communities are limited to the shoreline of Lake Michigan.

Beach.--Soil development is minimal because the sand is recently deposited. Two basic subdivisions can be distinguished: the nearly bare zone of sand nearest the lake and the better-vegetated grassland farther away.

Dominant plants: *Ammophila breviligulata*, *Calamovilfa longifolia*, *Elymus canadensis*.

Characteristic plants: *Cakile edentula*, *Corispermum hyssopifolium*, *Euphorbia polygonifolia*.

Characteristic animal: Piping plover.

Foredune.--The next successional stage is characterized by the beginnings of soil development. A fairly dense cover of low shrubs and grasses is present. There is some overlap with dry sand prairie.

Dominant plants: *Andropogon scoparius*, *Arctostaphylos uva-ursi*, *Juniperus horizontalis*.

Characteristic plants: *Juniperus communis*, *Petalostemum purpureum*.

Cave

A cave is a solution feature, collapse feature, or crevice underground. A cave is usually defined as being large enough to be enterable by a human being, and it usually has a part that is not penetrated by sunlight. Solution caves form in limestone or dolomite, but there is no significant difference between caves formed in the two kinds of rocks. Small caves form in sandstone, but these minor communities are not recognized in this classification. Two cave communities are distinguished: the *terrestrial cave community* and the *aquatic cave community*.

Terrestrial cave community.--This community consists of air-filled cavities in rock.

Distribution: The largest cave systems are in the Northern Section of the Ozark Division, but caves are also common in the Shawnee Hills Division and along the Mississipp River and lower Illinois River.

Characteristic animals: Little brown bat, big brown bat, eastern pipistrelle, cave salamander.

Aquatic cave community.--Pools, streams, and waterfalls in caves comprise this community. These waters are part of the groundwater in a region, and the water may come to the surface in springs and seeps.

Distribution: This community occurs with terrestrial cave communities.

Characteristic animals: There are many troglobitic (cave-adapted) aquatic invertebrates in Illinois. The spring cavefish inhabits some caves and springs.

Cultural

This community class includes communities that were created by human disturbance. In terms of natural quality, they are Grade D or E. All

Grade E communities are cultural communities, but not all Grade D communities are cultural. If land is Grade D because the original natural community has been destroyed by human activities and the land has recovered somewhat, then it is a cultural community. However, if the original natural community was not removed, or if secondary succession has progressed to the stage where, for example, a young forest exists, then the land is not a cultural community. For example, a recently clearcut forest is a Grade D forest, not a cultural community, because the original community was not completely altered. The cultural communities are described briefly below.

Cropland.--This includes row crops and forage crops.

Pastureland.--This includes open, pastured land, but not pastured forest.

Successional field.--The successional field community includes abandoned fields and abandoned pastures. It also includes any formerly disturbed open land which cannot be properly termed abandoned fields, such as roadsides and vacant lots.

Tree plantation.--Orchards, arboretums, and other tree plantations are in this artificial community.

Developed land.--Any sort of land that has been highly modified or has structures is placed in this class. It includes stripmined land, roadways, buildings, and cemeteries.

Artificial pond.--These are man-made bodies of water that have the characteristics of natural ponds.

Artificial lake.--This class includes large, man-made reservoirs.

Prairie restoration.--There are over 40 projects in Illinois to restore or create prairie communities on former farmland.

Bibliography of Natural Communities

About 350 scientific references are listed below. These are publications that provide descriptive information about natural communities in Illinois. The titles were selected from approximately 3,000 references

compiled by the Inventory regarding ecology, field biology, and natural areas in Illinois. Only studies that were completed in Illinois are included in the bibliography. Studies are not cited if they focused on individual species and did not describe a natural community or group of communities. No references to communities in the *cultural* community class are listed. Only a few Master's and Ph.D. theses are listed, in particular for natural communities that have received little attention from researchers. The winter bird-population studies and breeding-bird censuses in *Auk* and *American Birds* are not cited, and neither are the many valuable descriptions of the vegetation of Illinois in the *Geological Survey of Illinois* and *Economical Geology of Illinois* (see Worthen, 1866). The references do not form a complete bibliography of Illinois ecology: many important papers are not cited because they do not provide information about specific natural communities or groups of communities.

The citations are listed in an outline form, in a framework provided by the community classes, community subclasses, and natural communities. Each citation is listed at the most specific level possible in the classification hierarchy. For example, some papers are listed under the *forest community class* heading because they describe forest communities in general, but do not describe specific natural communities. Other papers are listed under the *upland forest community subclass*, because they have descriptive information about upland forests that is not referable to specific natural communities.

Under each community class, community subclass, and natural community heading, the references are grouped according to general subject categories. Each citation gives the author or authors, date of publication, and Natural Division and Section (according to the code listed in Figure 8). Natural Divisions or Sections are not listed for the *great lake* natural community: Lake Michigan probably should be placed in its own Natural Division rather than being considered a part of the adjacent Northeastern Morainal Division.

The bibliography is preliminary. A refined version is under preparation.

Annotated Outline of Bibliographic References

FOREST community class

Animal ecology: Auerbach (1951) 3a.

Fauna: Hart and Gleason (1907) 6a, 6b.

Flora: Mohlenbrock (1966) 13a; Ridgway (1873*a*) southern Illinois; Vestal (1919) 4a, 9a.

Presettlement vegetation: Anderson and Anderson (1975) 9b, 13a; Hanson (1978*b*) 3c; Kilburn (1959) 4a; Meyer (1952) 3c.

Vegetation: Chapman and Miller (1924) entire state; Engelmann (1863) 9b; Hall and Ingall (1911) entire state; Hart and Gleason (1907) 6a, 6b; Hudnut (1952) 4a; Miller (1923) southern Illinois; Ridgway (1873*a*, 1873*b*, 1882, 1894) southern Illinois; Telford (1926) entire state; Woodward (1925) 4a, 10c.

Upland forest community subclass

Fauna: Adams (1915) 4a; Hankinson (1915) 4a.

Flora: Fell and Fell (1957) 2a, 3d; Springer (1930) 4a; Turner (1936) 5a.

Hydrology: Bell and Johnson (1974) 4a.

Litter stratum: Bell and Sipp (1975) 4a.

Presettlement vegetation: Hutchison (1976) 13a, 13b; King and Johnson (1977) 4b.

Vegetation: Anderson and Adams (1978) central Illinois; Cowles (1901*a*, 1901*b*) 3a, 3c, 4a; DeForest (1921) 2a, 2b; Eikenberry (1912) 2a, 2b, 4a; Fuller and Strausbaugh (1919) 4a; Jackson and Petty (1971) 4a; Lindsey (1962) 10b; Miller (1919) 4a; Miller and Fuller (1922) 11c, 13b, 14a; Montgomery (1931) 2a, 2b; Pepoon (1910, 1919) 1; Schmoll (1919) 3a; Simmons (1921) 3a, 3c; Voigt and Mohlenbrock (1954) southern Illinois.

Xeric upland forest

Flora: Mohlenbrock (1968) 13a.

Dry upland forest

Flora: Hopkins (1969) 13a; Mohlenbrock (1967) 9b; Mohlenbrock and Voigt (1965) 11c; White (1971) 13b; Wiedman and Whiteside (1975) 10b.

Dry upland forest, cont.

Vegetation: Ashby and Kelting (1963) 11c; Fralish (1976) 13a; Ozment (1967) 11c, 13b.

Dry-mesic upland forest

Animal ecology: Blem and Blem (1975) 4a; Cole (1946) 4a; Strohecker (1937) 3a; Talbot (1934) 3a; Uetz (1976) 4a.

Disturbance: Helms and Jackson (1973) 10b.

Flora: Mohlenbrock (1967) 9b; Mohlenbrock (1968) 13a; Taylor (1920) 3a; White (1971) 13b; Wiedman and Whiteside (1975) 10b.

Microclimate: Ashby (1976) 13a; McDougall (1920) 10c; M'nutt and Fuller (1912) 3a; Ranft and Kilburn (1969) 8a; Thone (1922) 4a; Ullrich (1915) 3a.

Mineral cycling: Rolfe, et al. (1978) 13b.

Plant ecology: Akhtar, et al. (1976) 13a.

Soil: Bailey, et al. (1964) 4a; Kurz (1923) 1, 3a, 3c, 4a.

Vegetation: Ashby (1968) 13a; Ashby and Kelting (1963) 11c; Bell (1974*a*, 1974*b*) 4a; Bell and Sipp (1974) 4a; Blackmore and Ebinger (1967) 4a; Boggess and Geis (1967) 4a; Ebinger (1968, 1973) 4a; Ebinger and Parker (1969) 10b; Ebinger, et al. (1977) 4a; Fralish (1976) 13a; Hughes and Ebinger (1973) 10b; Johnson and Bell (1975) 4a; Kumler (1973) 8a; Kurz (1923) 1, 3a, 3c, 4a; Luvall and Weaver (1978) 11c; McClain and Ebinger (1968) 4a; McDougall (1919) 10c; Root, et al. (1971) 4a; Schlesinger (1976) 13b; Slifer (1976) 3a; Weaver and Ashby (1971) 13b.

Mesic upland forest

Animal ecology: Blake (1931) 4a; Davidson (1930, 1932) 4a; Jones (1946) 4a; Lindenborg (1941) 4a; Rice (1946) 4a; Shelford (1912) 3c; Shelford (1951) 4a; Smith (1928) 4a; Strohecker (1937) 3a; Twomey (1945) 4a; Weese (1924) 4a; Wetzel (1958) 4a.

Disturbance: McDougall (1925) 4a.

Fauna: Calef (1953) 4a; Frankland (1977) 3a; Wortman (1977) 3a.

Flora: Hus (1908) 8a; Taylor (1920) 3a; White (1971) 13b; Wiedman and Whiteside (1975) 10b.

Microclimate: Ashby (1976) 13a; McDougall (1920) 10c; Ullrich (1915) 3a.

Plant ecology: Bazzaz and Bliss (1971) 4a; McDougall (1922) 4a; McDougall and Liebtag (1928) 4a.

Soil: Bailey, et al. (1964) 4a; Geis and Boggess (1970) 4a; Geis, et al. (1970) 4a; Kurz (1923) 1.

Mesic upland forest, cont.

Vegetation: Ashby (1968) 13a; Ashby and Kelting (1963) 11c; Boggess (1964) 4a; Boggess and Bailey (1964) 4a; Boggess and Geis (1966) 4a; Cox, et al. (1972) 4a; Dunn and Jackson (1978) 10b, 10c; Ebinger and Parker (1969) 10b; Fralish (1976) 13a; Geis and Boggess (1970) 4a; Geis, et al. (1970) 4a; Hughes and Ebinger (1973) 10b; Kumler (1973) 8a; Kurz (1923) 1; McDougall (1919) 10c; Miceli, et al. (1977) 4a; Miller and Fuller (1922) 11c; Ozment (1967) 11a, 11c, 13b; Pelz and Rolfe (1977) 4a; Robertson and Pusateri (1976) 11c; Slifer (1976) 3a.

Wet-mesic upland forest

Flora: Vestal (1919) 9a.

Sand forest community subclass

Fauna: Johnson (1970) 6a.

Dry sand forest

Fauna: Gates (1911) 6a.

Dry-mesic sand forest

Fauna: Gates (1911) 6a.

Mesic sand forest

Flora: Fell (1957) 3d.

Floodplain forest community subclass

Animal ecology: Fawver (1947) 4a; Uetz (1976) 4a; Wetzel (1958) 4a.

Fauna: Adams (1915) 4a; Baker (1910) 3c; Garman (1888) 5b; Gates (1911) 5a; Hankinson (1915) 4a.

Flooding: Turner (1929) 5a.

Flora: Fell and Fell (1957) 2a, 3d; Mohlenbrock (1959) 12b; Mohlenbrock (1967) 9b; Springer (1930) 4a; Taylor (1920) 3a; Turner (1936) 5a.

Hydrology: Bell and Johnson (1974) 4a.

Floodplain forest community subclass, cont.

Litter stratum: Bell and Sipp (1975) 4a.

Presettlement vegetation: Hutchison (1976) 13a, 13b; King and Johnson (1977) 4b.

Vegetation: Bell (1974*a*) 4a; Cowles (1901*a*, 1901*b*) 3a, 3c, 4a; DeForest (1921) 2a, 2b; Franz (1971) 4a; Hosner and Minkler (1960) southern Illinois; Hosner and Minckler (1963) 9a, 9b, 12b, 13b, 14b; Lindsey (1962) 10a; Miller (1919) 4a; Nyboer and Ebinger (1976) 9a; Pepoon (1910) 5b; Pepoon (1919) 1; Ridgway (1882, 1894) 10a; Schmoll (1919) 3a; Voigt and Mohlenbrock (1954) southern Illinois.

Mesic floodplain forest

Flora: Hopkins (1969) 13a; Hus (1908) 12a; Mohlenbrock (1968) 13a; Mohlenbrock and Voigt (1965) 12b; White (1971) 14b.

Microclimate: Ashby (1976) 13a.

Vegetation: Ashby (1968) 13a; Ashby and Kelting (1963) 12b; Boggess and Geis (1966) 4a; Hughes and Ebinger (1973) 10b.

Wet-mesic floodplain forest

Animal ecology: Blem and Blem (1975) 4a.

Flora: White (1971) 14b.

Microclimate: Thone (1922) 4a.

Soil: Kurz (1923) 3a, 3c, 4a.

Vegetation: Ashby and Kelting (1963) 12b; Bell (1974*a*) 4a; Bell and Sipp (1974) 4a; Fuller and Strausbaugh (1919) 4a; Johnson and Bell (1975) 4a; Kumler (1973) 8a; Kurz (1923) 3a, 3c, 4a; McDougall (1919) 10c; Miller and Fuller (1922) 11c, 12b, 14b; Root, et al. (1971) 4a; Slifer (1977) 3a; Thomson and Anderson (1976) 12b.

Wet floodplain forest

Disturbance: Yaeger (1949) 5a.

Fauna: Goff (1952) 4a.

Flora: Hus (1908) 12a; Mohlenbrock and Voigt (1965) 12b; White (1971) 14b.

Microclimate: McDougall (1920) 10c.

Wet floodplain forest, cont.

Vegetation: Ashby and Kelting (1963) 12b; Bell (1974) 4a; Coulter (1903) 12a; Crites and Ebinger (1969) 4a; Evans (1975) 12b; Fuller and Strausbaugh (1919) 4a; McDougall (1919) 10c; Miller and Fuller (1922) 12b, 14b; Phillippe and Ebinger (1973) 10a; Thomson and Anderson (1976) 12b; Yaeger (1949) 5a.

Flatwoods community class

Northern flatwoods

Vegetation: Schmoll (1919) 3a; Simmons (1921) 3a; Waterman (1919) 3a.

Southern flatwoods

Vegetation: Borger (1968) 9b; Engelmann (1863) 9b; Vestal (1936) 9a, 9b.

Sand flatwoods

Soil: Isenbarger (1934) 3c; Kurz (1923) 3c.

Vegetation: Cowles (1901*a*, 1901*b*) 3c; Isenbarger (1934, 1947) 3c; Kurz (1923) 3c.

PRAIRIE community class

Fauna: Ridgway (1873*b*) 9b.

Flora: Bray (1957) entire state; Fuller (1925) 3c; Ridgway (1873*a*) southern Illinois; Short (1845) entire state; Turner (1934*a*) 5a.

Natural areas inventory: Bacone and Harty (1978) entire state.

Presettlement vegetation: Anderson (1970) entire state; Anderson and Anderson (1975) 9b, 13a; Hanson (1978*a*) 3c; Meyer (1952) 3c.

Vegetation: Cowles (1901*a*, 1901*b*) 3a, 3b, 3c, 4a; Vestal (1936) 9a, 9b.

Prairie community subclass

Animal ecology: Shackleford (1929) 4a; Talbot (1934) 3c.

Fauna: Adams (1915) 4a; Birkenholz (1973*a*, 1973*b*, 1975) 4a, 4e; Hankinson (1915) 4a; Long (1968) 4a.

Flora: Thompson and Heineke (1977) 9b; Turner (1936) 5a; Zales (1971) 4a, 4e.

Prairie community subclass, cont.

Natural areas inventory: Kerr and White (1978) 2a, 4a, 4c, 4d, 7a.

Presettlement vegetation: Kilburn (1959) 4a.

Soil: Douglas, et al. (1967) 4a.

Vegetation: Bacone and Harty (1978) 3a, 3d, 4a, 4b, 4d, 5b, 7a, 7b, 9a, 9b; Engelmann (1863) 9b; Hanson (1978*a*) 3c; Sampson (1921) entire state; Voigt and Mohlenbrock (1954) 9b.

Dry prairie

No references.

Dry-mesic prairie

No references.

Mesic prairie

Animal ecology: Auerbach (1951) 3a; Park, et al. (1949*a*, 1949*b*, 1953) 3a.

Flora: Vestal (1914) 3a.

Vegetation: Betz and Cole (1969) 3a; Betz and Lamp (1978) northern Illinois; Hanson (1975) 3c; Paintin (1928) 3a; Slifer (1977) 3a.

Wet-mesic prairie

No references.

Wet prairie

Fauna: Baker (1910) 3c; Gates (1911) 6a.

Flora: Vestal (1914) 3a.

Vegetation: Turner (1934*b*) 5a, 6a.

Sand prairie community subclass

Fauna: Hart and Gleason (1907) 6a, 6b; Vestal (1913) 6a.

Flora: Clute (1931) 4e; Gleason (1910) 3d, 4d, 4e, 6a, 6b; McDonald (1900) 6a; Pepoon (1909*a*) 6b; Vestal (1913) 6a.

Natural areas inventory: Kerr and White (1978) 4d.

<u>Sand prairie</u> community subclass, cont.

Vegetation: Bacone and Harty (1978) 3d, 4e, 6a, 6b; Betz and Lamp (1978) northern Illinois; Gleason (1910) 3d, 4d, 4e, 6a, 6b; Hanson (1978*a*) 3c; Hart and Gleason (1907) 6a, 6b; Ross (1963) 3b; Sampson (1921) entire state.

Dry sand prairie

Fauna: Gates (1911*b*) 6a.

Animal ecology: Johnson (1970) 6a.

Flora: Fell (1957) 3d.

Soil: Baier, et al. (1972) 6a.

Vegetation: Baier, et al. (1972) 6a; Gates (1912); Gleason (1909) 6b.

Dry-mesic sand prairie

Vegetation: Gates (1912) 3b; Hanson (1975) 3c.

Mesic sand prairie

Soil: Kurz (1923) 3c.

Vegetation: Gates (1912) 3b; Kurz (1923) 3c.

Wet-mesic sand prairie

Flora: Fell (1957) 3d.

Wet sand prairie

Vegetation: Gates (1912) 3b.

<u>Gravel prairie</u> community subclass

Vegetation: Fell and Fell (1956) 2a.

Dry gravel prairie

No references.

Dry-mesic gravel prairie

No references.

Mesic gravel prairie

No references.

Dolomite prairie community subclass

Dry dolomite prairie

No references.

Dry-mesic dolomite prairie

No references.

Mesic dolomite prairie

No references.

Wet-mesic dolomite prairie

No references.

Wet dolomite prairie

No references.

Hill prairie community subclass

Flora: Evers (1955) 1, 2a, 2b, 4a, 4b, 6a, 8a, 8b, 11a, 11c, 13a.

Natural areas inventory: Kerr and White (1978) 4a, 4b.

Loess hill prairie

Disturbance: Nyboer (1978) 8a, 8b.

Loess hill prairie, cont.

Fauna: Ozment (1967) 11a.

Flora: Hus (1908) 8a; Mohlenbrock and Voigt (1965) 11c.

Microclimate: Ranft and Kilburn (1969) 8a.

Soil: Bland and Kilburn (1966) 8a; Kilburn and Warren (1963) 8a.

Vegetation: Bland and Kilburn (1966) 8a; Evers (1955) entire state; Kilburn and Ford (1963) 8a; Kilburn and Warren (1963) 8a; Ozment (1967) 11a, 11c; Voigt and Mohlenbrock (1964) 11a, 11c.

Glacial drift hill prairie

Vegetation: Reeves (1976) 4a; Vestal (1918) 4a.

Gravel hill prairie

No references.

Sand hill prairie

No references.

Shrub prairie community subclass

Shrub prairie

Flora: Armstrong (1963) 3c; Fell (1957) 3d; Ridgway (1873*a*) southern Illinois.

Vegetation: Armstrong (1963) 3c.

SAVANNA community class

Flora: Ridgway (1873*a*) southern Illinois.

Presettlement vegetation: Anderson and Anderson (1975) 9b, 13a; Hanson (1978*b*) 3c; Meyer (1952) 3c.

Vegetation: Engelmann (1963) 9b; Madany (1978) entire state; Vestal (1936) 9a, 9b.

Savanna community subclass

Natural areas inventory: Kerr and White (1978) 4a, 7a, 9a, 10c.

Presettlement vegetation: Kilburn (1959) 4a.

Savanna community subclass, cont.

Vegetation: Betz and Lamp (1978) northern Illinois; Eikenberry (1912) 2a, 2b, 4a; Fuller and Strausbaugh (1919) 4a.

Dry-mesic savanna

No references.

Mesic savanna

No references.

Sand savanna community subclass

Animal ecology: Lowrie (1942) 3b, 4e.

Fauna: Hart and Gleason (1907) 6a, 6b.

Flora: Fell (1957) 3d; Gleason (1910) 3d, 4d, 4e, 6a, 6b.

Natural areas inventory: Kerr and White (1978) 4e.

Vegetation: Betz and Lamp (1978) northern Illinois; Gleason (1909) 6b; Gleason (1910) 3d, 4d, 4e, 6a, 6b; Hart and Gleason (1907) 6a, 6b.

Dry sand savanna

Fauna: Johnson (1970) 6a.

Vegetation: Gates (1912) 3b.

Dry-mesic sand savanna

Flora: Armstrong (1963) 3c; Clute (1931) 4e.

Soil: Kurz (1923) 3c.

Vegetation: Armstrong (1963) 3c; Kurz (1923) 3c.

Barren community subclass

Presettlement vegetation: Hutchison (1976) 13b.

Dry barren

Flora: Rowe (1976) 8a.

Dry-mesic barren

No references.

Mesic barren

Vegetation management: Anderson and Schwegman (1971) 14a.

WETLAND community class

Fauna: Beecher (1942) 3a; Fuller (1925) 3c.

Presettlement vegetation: Hanson (1978*b*) 3c; Meyer (1952) 3c.

Soil: Hopkins, et al. (1912) central and northern Illinois.

Vegetation: Cowles (1901*a*, 1901*b*) 3a, 3b, 3c, 4a.

Marsh community subclass

Marsh

Fauna: Baker (1910) 3c; Frankland (1977) 3a; Gates (1911*b*) 6a; Wortman (1977) 3a.

Flora: Armstrong (1963) 3c; Peattie (1925) 3c.

Vegetation: Armstrong (1963) 3c; Coulter (1903) 3c, 12a; Gates (1912) 3b; Hughes (1977) 3a.

Brackish marsh

Geology: Cady (1919) 4a.

Swamp community subclass

Swamp

Flora: White (1971) 14b.

Mineral cycling: Dorge (1977*c*) 14b; Dorge and Mitsch (1977*a*) 14b.

Plant ecology: Dorge and Mitsch (1977*b*) 14b; Hickey and Dorge (1977) 14b.

Sediments: Dorge and Mitsch (1977*c*) 14b.

Vegetation: Anderson and White (1970) 14b.

Water: Wiemhoff (1977*a*, 1977*b*, 1977*c*) 14b.

Water chemistry: Dorge (1977*a*, 1977*b*), 14b.

Shrub swamp

Fauna: Gates (1911*b*) 5a; Gunning and Lewis (1955) 12a.

Flora: Mohlenbrock (1959) 12b; Mohlenbrock and Voigt (1965) 12b; White (1971) 14b.

Vegetation: Ashby and Kelting (1963) 12b; Coulter (1903) 12a; Voigt and Mohlenbrock (1954) southern Illinois.

Bog community subclass

Fauna: Reichle (1969) 3a.

Geology: McConas, et al. (1972) 3a.

Hydrology: McConas, et al. (1972) 3a.

Soil: Isenbarger (1934) 3a; Kurz (1928) 3a; McConas, et al. (1972) 3a.

Vegetation: Isenbarger (1934) 3a; Kurz (1928) 3a; Reichle and Doyle (1965) 3a; Waterman (1921, 1923, 1926) 3a.

Vegetation history: Artist (1936) 3a; Stiernberg (1971) 3a; Voss (1931) 3a.

Graminoid bog

Vegetation: Sheviak and Haney (1973) 3a.

Low shrub bog

Vegetation: Duerr (1967) 3a; Sheviak and Haney (1973) 3a.

Tall shrub bog

Vegetation: Sheviak and Haney (1973) 3a.

Forested bog

Vegetation: Sheviak and Haney (1973) 3a.

Vegetation history: Voss (1931) 3a.

Fen community subclass

Paleontology: Leonard (1974) 4a.

Calcareous floating mat

No references.

Graminoid fen

Vegetation: Moran (1978) 3a.

Low shrub fen

No references.

Tall shrub fen

No references.

Forested fen

No references.

Sedge meadow community subclass

Sedge meadow

Fauna: Frankland (1976) 3a.

Flora: Armstrong (1963) 3c; Clute (1931) 4e; Fell (1957) 3d.

Vegetation: Armstrong (1963) 3c; Gates (1912) 3b; Hughes (1977) 3a.

Panne community subclass

Panne

Vegetation: Gates (1912) 3b.

Seep and spring community subclass

Seep

Flora: Gates (1911*a*) 6a; Mohlenbrock and Voigt (1959) 9b; Phipps and Speer (1958) 4a.

Vegetation: Parker and Ebinger (1971) 4a; Phipps and Speer (1958) 4a.

Acid gravel seep

Flora: Schwegman (1969) 14a.

Vegetation: Schwegman (1969) 14a.

Calcareous seep

Tufa: Decker (1912) 10c.

Sand seep

No references.

Spring community

Fauna: Gunning and Lewis (1955) 12b; Weise (1957) 12b.

Flora: Mohlenbrock (1959) 12b; Mohlenbrock and Voigt (1965) 12b.

Vegetation: Hopkins (1969) 12b, 13a, 13b.

Water: Hutchison (1976) 13b.

LAKE AND POND community class

Bibliography: Smith (1978) entire state.

Fauna: Forbes and Richardson (1908) entire state; Parmalee (1967) entire state; Smith (1978) entire state.

Pond community class

Pond

Animal ecology: Dorris (1958) 5b; Shelford (1911*b*) 3b.

Disturbance: Mills, et al. (1966) 5a.

Fauna: Baker (1910) 3c; Garman (1888) 5b; Gunning and Lewis (1955) 12a; Hart (1895) 5a; Hempel (1899) 5a; Krull and Hubert (1973) 12b; Mills, et al. (1966) 5a; Richardson (1921*a*, 1921*b*, 1928) 5a.

Flora: Hus (1908) 12a; Mohlenbrock and Voigt (1965) 12b; White (1971) 14b.

Palynology: Griffin (1951) 4a; Gruger (1972) 9a.

Plankton: Eddy (1931) 13b; Eddy (1934) entire state; Kofoid (1903) 5a.

Pond, cont.

Plant ecology: Mathis, et al. (1969) 5a.

Vegetation: Ashby and Kelting (1963) 12b; Bellrose (1941) 5a; Coulter (1903) 12a; Cowles (1901*a*, 1901*b*) 3a, 3b, 3c, 4a; Gates (1912) 3b; Mohlenbrock (1959) 12b.

Lake community subclass

Lake

Chemistry: Wang and Evans (1971) 5a.

Community metabolism: Mathis and Meyers (1970) 5a.

Disturbance: Mills, et al. (1966) 5a.

Fauna: Garman (1888) 5b; Gunning (1955) 14b; Hart (1895) 5a; Hempel (1899) 5a; Mills, et al. (1966) 5a; Paloumpis and Starrett (1960) 5a; Richardson (1921*a*, 1921*b*, 1925*a*, 1928) 5a; Starrett and Fritz (1965) 5a.

Flora: Peattie (1925) 3c; Wunderlin and Wunderlin (1962) 14b.

Plankton: Eddy (1934) entire state; Ingle-Stroh (1977) 3a; Kofoid (1903) 5a.

Vegetation: Bellrose (1941) 5a; Coulter (1903) 3c.

Great lake

Bibliography: Gannon (1969); Illinois Natural History Survey (1976); Van Oosten (1958).

Disturbance: Illinois Natural History Survey (1976); Wells and McLain (1973); Woods (1970).

Fauna: Baker (1929); Becker (1976); Illinois Natural History Survey (1976); Stimpson, et al. (1975) ; Wells and McLain (1973).

Flora: Briggs (1872); Dailey (1938); Damann (1941, 1945); Skvortzow (1937); Thomas and Chase (1887); Tarapchak and Stoermer (1976).

Physical limnology: Mortimer and Csanady (1975).

Plankton: Eddy (1927); Lackey (1944).

Water chemistry: Torrey (1976).

Water quality: Beer (1971).

STREAM community class

Animal ecology: Gersbacher (1937) 4a.

Bibliography: Smith (1978) entire state.

STREAM community class, cont.

Disturbance: Baker (1922) 4a, 10c; Smith (1968) 4a, 9a, 9b, 10a, 10c; Smith (1971) entire state.

Fauna: Baker (1922) 4a, 10c; Baker (1927) 2a, 2b, 3d, 4a, 4d, 5b; Forbes and Richardson (1908) entire state; Parmalee (1967) entire state; Smith (1978) entire state.

Flora: Lin, et al. (1973) 7a.

Hydrology: Curtis (1969) entire state; Lara (1970) entire state; Mitchell (1950, 1954, 1957) entire state; Singh (1971) entire state; Singh and Stall (1973) entire state; Stall and Fok (1968) entire state; U. S. Geological Survey, Water Resources Division (for example, 1978) entire state.

Plankton: Eddy (1934) entire state.

Water quality: Kothandaraman and Evans (1977*a*, 1977*b*) 7a; Lin, et al. (1974) 7a; U. S. Geological Survey, Water Resources Division (for example, 1978) entire state.

Creek community subclass

Disturbance: Larimore and Smith (1963) 4a, 10c.

Fauna: Alexander (1924) 4a; Buth (1974) 4a; Hankinson (1910) 4a; Smith, et al. (1969) 7b, 8a.

Water quality: Aubertin (1978) 11c, 13a, 13b; Aubertin and Case (1978) 13a.

Low-gradient creek

Animal ecology: Shelford (1911*a*) 3a, 3b.

Fauna: Baker (1910) 3c; Garman (1888) 5b; Hankinson (1913) 4a; Larimore and Smith (1963) 4a; Ross (1963) 3b; Stegman (1959) 12b; Thompson and Hunt (1930) 4a.

Flora: Solheim and Penfound (1928) 4a; White (1971) 14b.

Plankton: Kofoid (1903) 5a.

Medium-gradient creek

Animal ecology: Shelford (1911*a*) 3a.

Fauna: Baker and Smith (1919) 4a, 10c; Drew and Wildrick (1974) 4a; Forbes and Richardson (1913) 3a; Hankinson (1913) 4a; Larimore and Smith (1963) 4a, 10c; Larimore, et al. (1952) 4a, 10c; Lewis (1957) 13b; Small (1973) 4a; Stegman (1959) 9b; Thompson and Hunt (1930) 4a, 10c.

Medium-gradient creek, cont.

Flora: Solheim and Penfound (1928) 4a.

High-gradient creek

Animal ecology: Shelford (1911*a*) 3a.

Fauna: Gunning and Lewis (1956) 13a; Hankinson (1913) 4a; Larimore and Smith (1963) 4a; Lewis (1957) 13b; Stegman (1959) 9b; Thompson and Hunt (1930) 4a; Putz and Thomerson (1972) 8a, 9a, 11a.

Flora: Hopkins (1969) 13a; Mohlenbrock (1968) 13a.

River community subclass

Low-gradient river

Disturbance: Larimore and Smith (1963) 4a.

Fauna: Larimore and Smith (1963) 4a; Lewis (1954) 9b, 12b; Luce (1933) 4a, 9a, 9b; Putz and Thomerson (1972) 12a; Thompson and Hunt (1930) 4a.

Flora: White (1971) 14b.

Hydrology: Kendeigh (1973) 4a.

Plankton: Eddy (1931*b*) 4a, 4b; Ingle-Stroh (1977) 3a.

Water quality: Jewell (1920) 4a; Jewell (1922) 9b, 12b.

Medium-gradient river

Animal ecology: Nilsen and Larimore (1973) 4a.

Fauna: Alexander (1924) 4a, 10c; Hankinson (1913) 4a; Strode (1892) 7a.

Flora: Lipsey (1975) 3a.

Major river

Bibliography: Mills, et al. (1966) 4a, 5a.

Disturbance: Bartow (1913) 4a, 5a; Forbes and Richardson (1919) 5a; Mills, et al. (1966) 4a, 5a; Starrett (1971, 1972) 4a, 5a.

Fauna: Baker (1903) 5b; Barnickol and Starrett (1951) 5b; Carlson (1968) 5b; Dorris (1956) 5b; Forbes and Richardson (1919) 5a; Garman (1888) 5b; Gates (1911*b*) 5a; Grier and Mueller (1922-1923) 5b, 12a, 12b; Hart (1895) 5a; Hempel (1899) 5a; Mills, et al. (1966) 4a, 5a; Richardson (1921*a*, 1921*b*, 1925*a*, 1925*b*, 1928) 5a; Starrett (1971) 4a, 5a; Van der Schalie and Van der Schalie (1950) 5b, 12a.

Major river, cont.

Flora: Evans (1978) 12b; Hus (1908) 12a; Kennedy and Mohlenbrock (1963) 14b.

Plankton: Forbes and Richardson (1913) 4a, 5a; Kofoid (1903, 1908) 5a.

Vegetation: Evans (1975) 12a, 12b.

Water quality: Greenfield (1925) 4a, 5a; Kothandaraman and Sinclair (1975) 5a.

PRIMARY community class

Presettlement vegetation: Hutchison (1976) 13b.

Glade community subclass

Sandstone glade

Flora: Hatcher (1952) 13a; Hopkins (1969) 13a; Mohlenbrock (1966, 1968) 13a.

Microclimate: Ashby (1976) 13a.

Vegetation: Fralish (1976) 13a; Winterringer and Vestal (1956) 13a, 13b.

Limestone glade

Fauna: Ozment (1967) 11a.

Flora: Evers (1955) 11a, 13b; White (1971) 13b.

Plant ecology: Kurz (1978) 8a, 8b, 11a, 11c, 13a, 13b.

Vegetation: Ozment (1967) 11a, 13b.

Shale glade

No references.

Cliff community subclass

Sandstone cliff community

Flora: Ebinger (1978) 10b; Fell and Fell (1949) 2b; Hatcher (1952) 13a; Hopkins (1969) 13a; White (1971) 13b; Wiedman and Whiteside (1975) 10b.

Sandstone cliff community, cont.

Microclimate: Ashby (1976) 13a; Thone (1923) 4a.

Plant ecology: Steagal (1926) 13a.

Vegetation: Cowles (1901*a*, 1901*b*) 4a; Eikenberry (1912) 2b.

Limestone cliff community

Flora: Hatcher (1952) 11c; Hus (1908) 8a; Mohlenbrock and Voigt (1965) 11c; Turner (1936) 5a.

Plant ecology: Steagal (1926) 11c, 13a.

Vegetation: Ozment (1967) 11a, 11c, 13b.

Dolomite cliff community

Flora: Fell and Fell (1949, 1957) 2a, 3d; Pepoon (1909*a*, 1909*b*, 1917) 1; Taylor (1920) 2a, 3a.

Vegetation: Eikenberry (1912) 2a; Pepoon (1910) 1.

Sandstone overhang community

No references.

Eroding bluff community

Flora: Fuller (1925) 3a; Taylor (1920) 3a.

Geology: Berg and Collinson (1976) 3a.

Vegetation: Cowles (1901*a*, 1901*b*) 3a; Fuller and Strausbaugh (1919) 4a; Illinois Natural History Survey (1976) 3a; Schmoll (1919) 3a; Simmons (1921) 3a.

Lake shore community subclass

Animal ecology: Lowrie (1942) 3b; Strohecker (1937) 3b.

Flora: Fuller (1925) 3b.

Vegetation: Atwell (1932) 3b; Cowles (1899) 3c; Gates (1910) 3b.

Beach

Fauna: Snow (1902) 3c.

Geology: Needham (1929) 3b.

Beach, cont.

Vegetation: Cowles (1901*a*, 1901*b*) 3b; Gates (1912) 3b; Ross (1963) 3b.

Foredune

Vegetation: Cowles (1901*a*, 1901*b*) 3b; Gates (1912) 3b; Ross (1963) 3b.

CAVE community class

Cave community subclass

Bibliography: Peck and Lewis (1978) entire state.

Geology: Bretz and Harris (1961) 1, 2a, 4a, 8a, 8b, 9b, 11a, 13a, 13b.

Terrestrial cave community

Fauna: Kerr (1973) 8a; Peck and Lewis (1978) entire state; Skaggs (1973) 8a; Whitaker (1977) 13a, 13b.

Flora: Liang (1970) 8a.

Geology: Bretz (1938) 1; Harris and Allen (1952) 13b.

Aquatic cave community

Fauna: Peck and Lewis (1978) entire state; Weise (1957) 11c.

Bibliography of Natural Community References

Adams, C. C. 1915. An ecological study of prairie and forest invertebrates. Bulletin of the Illinois State Laboratory of Natural History 11:33-280.

Akhtar, M. A., G. L. Rolfe, and L. E. Arnold. 1976. Nutrient cycling in oak-hickory forests. I. Precipitation, throughfall and stemflow. P. 347-361 *in* J. S. Fralish, G. T. Weaver, and R. C. Schlesinger, eds. Central Hardwood Conference, proceedings of the first meeting. Southern Illinois University, Carbondale.

Alexander, C. P. 1924. An entomological survey of the Salt Fork of the Vermilion River in 1921, with a bibliography of aquatic insects. Bulletin of the Illinois State Natural History Survey 15:439-535.

Anderson, R. C. 1970. Prairies in the Prairie State. Transactions of the Illinois State Academy of Science 63:214-221.

Anderson, R. C. and D. E. Adams. 1978. Species replacement patterns in central Illinois white oak forests. P. 284-301 *in* P. E. Pope, ed. Central Hardwood Forest Conference II proceedings. Purdue University, West Lafayette, Indiana.

Anderson, R. C. and M. R. Anderson. 1975. The presettlement vegetation of Williamson County, Illinois. Castanea 40:345-363.

Anderson, R. C. and J. Schwegman. 1971. The response of southern Illinois barren vegetation to prescribed burning. Transactions of the Illinois State Academy of Science 64:287-291.

Anderson, R. C. and J. White. 1970. A cypress swamp outlier in southern Illinois. Transactions of the Illinois State Academy of Science 63:6-13.

Armstrong, A. C. 1963. The vegetation of Zanders Woods with emphasis on the sand pits. Master's thesis. Chicago State University.

Artist, R. C. 1936. Stratigraphy and preliminary pollen analysis of a Lake County, Illinois bog. Butler University Botanical Studies 3:191-198.

Ashby, W. C. 1968. Forest types of Lusk Creek in Pope County, Illinois. Transactions of the Illinois State Academy of Science 61: 348-355.

Ashby, W. C. 1976. Climatic features of vegetation types in southeastern Illinois. P. 89-98 *in* J. S. Fralish, G. T. Weaver, and R. C. Schlesinger, eds. Central Hardwood Conference, proceedings of the first meeting. Southern Illinois University, Carbondale.

Ashby, W. C. and R. W. Kelting. 1963. Vegetation of the Pine Hills Field Station in southwestern Illinois. Transactions of the Illinois State Academy of Science 56:188-201.

Atwell, C. B. 1932. Three dune associations compared. Torreya 32:109-115.

Aubertin, G. M. 1978. Water quality from relatively undisturbed forested areas in southern Illinois. P. 179-200 *in* P. E. Pope, ed. Central Hardwood Forest Conference II proceedings. Purdue University, West Lafayette, Indiana.

Aubertin, G. M. and P. J. Case. 1978. The effect of land use on water quality. P. 228-242 *in* P. E. Pope, ed. Central Hardwood Forest Conference II proceedings. Purdue University, West Lafayette, Indiana.

Auerbach, S. I. 1951. The centipedes of the Chicago area with special reference to their ecology. Ecological Monographs 21:97-124.

Bacone, J. A. and F. M. Harty. 1978. An inventory of railroad prairie remnants in Illinois. P. 19 *in* Abstracts of contributed papers for the Sixth North American Prairie Conference. Ohio State University, Columbus.

Baier, J. D., F. A. Bazzaz, L. C. Bliss, and W. R. Boggess. 1972. Primary production and soil relations in an Illinois sand prairie. American Midland Naturalist 88:200-208.

Bailey, L. W., R. T. Odell, and W. R. Boggess. 1964. Properties of soil developed near the forest-prairie border in east-central Illinois. Soil Science Society of America Proceedings 28:257-263.

Baker, F. C. 1903. Shell collecting on the Mississippi. Nautilus 16: 102-105.

Baker, F. C. 1910. The ecology of the Skokie Marsh area, with special reference to the Mollusca. Bulletin of the Illinois State Laboratory of Natural History 8:441-499.

Baker, F. C. 1922. The molluscan fauna of the Big Vermilion River, Illinois. Illinois Biological Monographs 7(2):1-127.

Baker, F. C. 1927. The naiad fauna of the Rock River system: A study of the law of stream distribution. Transactions of the Illinois State Academy of Science 19:103-112.

Baker, F. C. 1929. The molluscan fauna of the southern part of Lake Michigan and its relationship to old glacial Lake Chicago. Transactions of the Illinois State Academy of Science 22:186-194.

Baker, F. C. and F. Smith. 1919. A mussel survey of the upper waters of the Vermilion River with special reference to the Salt Fork. Transactions of the Illinois State Academy of Science 12:129-131.

Barnickol, P. G. and W. C. Starrett. 1951. Commercial and sport fishes of the Mississippi River between Caruthersville, Missouri, and Dubuque, Iowa. Illinois Natural History Survey Bulletin 25:267-350.

Bartow, E. 1913. Chemical and biological survey of the waters of Illinois: Effect of Chicago sewage on the Illinois River. University of Illinois Bulletin 10, Water Survey Series 10:30-45.

Bazzaz, F. A. and L. C. Bliss. 1971. Net primary production of herbs in a central Illinois deciduous forest. Bulletin of the Torrey Botanical Club 98:90-94.

Becker, G. C. 1976. Inland fishes of the Lake Michigan drainage basin. Environmental status of the Lake Michigan region, Volume 17. National Technical Information Service, Springfield, Virginia. 237 p.

Beecher, W. J. 1942. Nesting birds and vegetation substrate. Chicago Ornithological Society, Chicago. 69 p.

Beer, L. P. 1971. Natural and unnatural water temperatures in Zion-Waukegan, Illinois area of southwest Lake Michigan. Proceedings of the Conference on Great Lakes Research 14:507-521.

Bell, D. T. 1974*a*. Studies on the ecology of the streamside forest: Composition and distribution of vegetation beneath the canopy. Bulletin of the Torrey Botanical Club 101:14-20.

Bell, D. T. 1974*b*. Tree stratum composition and distribution in the streamside forest. American Midland Naturalist 92:35-46.

Bell, D. T. and F. L. Johnson. 1974. Ground water level in the flood plain and adjacent uplands of the Sangamon River. Transactions of the Illinois State Academy of Science 67:376-383.

Bell, D. T. and S. K. Sipp. 1974. Gradient analysis of the streamside forest in the Hart Memorial Woods, Champaign County, Illinois. University of Illinois Agricultural Experiment Station Forestry Research Report 74-5. 3 p.

Bell, D. T. and S. K. Sipp. 1975. The litter stratum in the streamside forest ecosystem. Oikos 26:391-397.

Bellrose, F. C., Jr. 1941. Duck food plants of the Illinois River valley. Illinois Natural History Survey Bulletin 21:237-280.

Berg, R. C. and C. Collinson. 1976. Bluff erosion, recession rates, and volumetric losses on the Lake Michigan shore in Illinois. Illinois State Geological Survey Environmental Geology Notes 76. 33 p.

Betz, R. F. and M. H. Cole. 1969. The Peacock Prairie--a study of a virgin Illinois mesic black-soil prairie forty years after initial study. Transactions of the Illinois State Academy of Science 62: 44-53.

Betz, R. F. and H. F. Lamp. 1978. The species composition of old settler cemeteries in northern Illinois. P. 22 *in* Abstracts of contributed papers for the Sixth North American Prairie Conference. Ohio State University, Columbus.

Birkenholz, D. E. 1973*a*. Habitat relationships of grassland birds at Goose Lake Prairie Nature Preserve. P. 63-66 *in* L. C. Hulbert, ed. Third Midwest Prairie Conference proceedings. Kansas State University, Manhattan.

Birkenholz, D. E. 1973*b*. Mammals of Goose Lake Prairie Nature Preserve. Chicago Academy of Sciences Natural History Miscellanea 191. 10 p.

Birkenholz, D. E. 1975. The summer birds of Goose Lake Prairie Nature Preserve. Chicago Academy of Sciences Natural History Miscellanea 193. 11 p.

Blackmore, B. K. and J. E. Ebinger. 1967. Vegetation survey of Burgner Acres, east-central Illinois. Transactions of the Illinois State Academy of Science 60:72-79.

Blake, I. H. 1931. Further studies on deciduous forest animal communities. Ecology 12:508-527.

Bland, M. K. and P. D. Kilburn. 1966. Bluff prairie vegetation and soil texture. Transactions of the Illinois State Academy of Science 59: 25-28.

Blem, C. R. and L. B. Blem. 1975. Density, biomass, and energetics of the bird and small mammal populations of an Illinois deciduous forest. Transactions of the Illinois State Academy of Science 68:156-164.

Boggess, W. R. 1964. Trelease Woods, Champaign County, Illinois: Woody vegetation and stand composition. Transactions of the Illinois State Academy of Science 57:261-271.

Boggess, W. R. and L. W. Bailey. 1964. Brownfield Woods, Illinois: Woody vegetation and changes since 1925. American Midland Naturalist 71:392-401.

Boggess, W. R. and J. W. Geis. 1966. The Funk Forest Natural Area, McLean County, Illinois: Woody vegetation and ecological trends. Transactions of the Illinois State Academy of Science 59:123-133.

Boggess, W. R. and J. W. Geis. 1967. Composition of an upland, streamside forest in Piatt County, Illinois. American Midland Naturalist 78:89-97.

Borger, W. M. 1968. A phytosociological survey of a post oak (*Quercus stellata*) community at Crab Orchard National Wildlife Refuge. Research report. Southern Illinois University, Carbondale. 12 p.

Bray, J. R. 1957. Climax forest herbs in prairie. American Midland Naturalist 58:434-440.

Briggs, S. A. 1872. The Diatomaceae of Lake Michigan. The Lens 1:41-44.

Bretz, J H. 1938. Caves in the Galena Formation. Journal of Geology 46:825-841.

Bretz, J H. and S. E. Harris, Jr. 1961. Caves of Illinois. Illinois State Geological Survey Report of Investigations 215. 87 p.

Buth, D. G. 1974. An analysis of the fish fauna of the Embarras River in Illinois. Transactions of the Illinois State Academy of Science 67:47-59.

Cady, G. H. 1919. Geology and mineral resources of the Hennepin and LaSalle quadrangles. Illinois State Geological Survey Bulletin 37: 1-136.

Calef, R. T. 1953. Avian populations of the Funk Forest Natural Area in McLean County, Illinois. Transactions of the Illinois State Academy of Science 46:240-257.

Carlson, C. A. 1968. Summer bottom fauna of the Mississippi River above Dam 19, Keokuk, Iowa. Ecology 49:162-169.

Chapman, H. H. and R. B. Miller. 1924. Second report on a forestry survey of Illinois. Bulletin of the Illinois State Natural History Survey 15:46-172.

Clute, W. N. 1931. Swamp and dune: A study in plant distribution. Indianapolis.

Cole, L. C. 1946. A study of the cryptozoa of an Illinois woodland. Ecological Monographs 16:49-86.

Coulter, S. M. 1903. An ecological comparison of some typical swamp areas. Annual Report of the Missouri Botanical Garden 15:38-71.

Cowles, H. C. 1899. The ecological relations of the vegetation on the sand dunes of Lake Michigan. Botanical Gazette 27:95-117, 167-202, 281-308, 361-391.

Cowles, H. C. 1901*a*. The physiographic ecology of Chicago and vicinity; a study of the origin, development, and classification of plant societies. Botanical Gazette 31:73-108, 145-182.

Cowles, H. C. 1901*b*. The plant societies of Chicago and vicinity. Geographical Society of Chicago Bulletin 2. 76 p.

Cox, D. L., M. Miller, and J. A. Hostetler. 1972. Succession in and composition of a central Illinois prairie grove. Transactions of the Illinois State Academy of Science 65(1-2):33-41.

Crites, R. W. and J. E. Ebinger. 1969. Vegetation survey of floodplain forests in east-central Illinois. Transactions of the Illinois State Academy of Science 62:316-330.

Curtis, G. W. 1969. Statistical summaries of Illinois streamflow data. U. S. Geological Survey, Water Resources Division open-file report. Champaign, Illinois. 300 p.

Daily, W. A. 1938. A quantitative study of the phytoplankton of Lake Michigan collected in the vicinity of Evanston, Illinois. Butler University Botanical Studies 4:65-83.

Damann, K. E. 1941. Quantitative study of the phytoplankton of Lake Michigan at Evanston, Illinois. Butler University Botanical Studies 5:27-44.

Damann, K. E. 1945. Plankton studies of Lake Michigan. I. Seventeen years of plankton data collected at Chicago, Illinois. American Midland Naturalist 34:769-796.

Davidson, V. S. 1930. The tree layer society of the maple--red oak climax forest. Ecology 11:601-620.

Davidson, V. S. 1932. The effect of seasonal variability upon animal species in total populations in a deciduous forest succession. Ecological Monographs 2:305-323.

Decker, C. E. 1912. A tufa deposit near Danville, Illinois. Transactions of the Illinois State Academy of Science 5:109-111.

DeForest, H. 1921. The plant ecology of the Rock River woodlands of Ogle County. Transactions of the Illinois State Academy of Science 14:152-193.

Dorge, C. L. 1977*a*. Chemical interactions between Heron Pond and the Cache River. P. 120-134 *in* W. J. Mitsch, C. L. Dorge, and J. R. Wiemhoff. Forested wetlands for water resource management in southern Illinois. University of Illinois Water Resource Center, Urbana.

Dorge, C. L. 1977*b*. Heron Pond water chemistry. P. 91-119 *in* W. J. Mitsch, C. L. Dorge, and J. R. Wiemhoff. Forested wetlands for water resource management in southern Illinois. University of Illinois Water Resource Center, Urbana.

Dorge, C. L. 1977*c*. Phosphorus dynamics in a swamp microcosm. P. 135-145 *in* W. J. Mitsch, C. L. Dorge, and J. R. Wiemhoff. Forested wetlands for water resource management in southern Illinois. University of Illinois Water Resource Center, Urbana.

Dorge, C. L. and W. J. Mitsch. 1977*a*. A phosphorus budget for Heron Pond. P. 198-217 *in* W. J. Mitsch, C. L. Dorge, and J. R. Wiemhoff. Forested wetlands for water resource management in southern Illinois. University of Illinois Water Resources Center, Urbana.

Dorge, C. L. and W. J. Mitsch. 1977*b*. Net primary productivity and biomass of vegetation in Heron Pond. P. 164-189 *in* W. J. Mitsch, C. L. Dorge, and J. R. Wiemhoff. Forested wetlands for water resource management in southern Illinois. University of Illinois Water Resource Center, Urbana.

Dorge, C. L. and W. J. Mitsch. 1977*c*. Sedimentation rates and sediment analysis in Heron Pond. P. 146-163 *in* W. J. Mitsch, C. L. Dorge, and J. R. Wiemhoff. Forested wetlands for water resource management in southern Illinois. University of Illinois Water Resource Center, Urbana.

Dorris, T. C. 1956. Limnology of the middle Mississippi River and adjacent waters. II. Observations on the life histories of some aquatic Diptera. Transactions of the Illinois State Academy of Science 48:27-33.

Dorris, T. C. 1958. Limnology of the middle Mississippi River and adjacent waters. Lakes on the leveed floodplain. American Midland Naturalist 59:82-110.

Douglas, C. L., Jr., J. B. Fehrenbacher, and B. W. Ray. 1967. The lower boundary of selected mollisols. Soil Science Society of America Proceedings 31:795-800.

Drew, A. W. and D. M. Wildrick. 1974. A pre-impoundment study of the fish fauna of Indian Creek, DeKalb County, Illinois. Transactions of the Illinois State Academy of Science 67:68-73.

Duerr, J. J. 1967. A study of succession on an acid peat bog in Kane County, Illinois. Master's thesis. Northern Illinois University, DeKalb.

Dunn, C. P. and M. T. Jackson. 1978. Phytosociological and ordination analyses of the tree stratum of the beech--maple forest type. P. 2-21 *in* P. E. Pope, ed. Central Hardwood Forest Conference II proceedings. Purdue University, West Lafayette, Indiana.

Ebinger, J. E. 1968. Woody vegetation survey of Sargents Woods, Coles County, Illinois. Transactions of the Illinois State Academy of Science 61:16-25.

Ebinger, J. E. 1973. Coppice forest in east-central Illinois. Castanea 38:152-163.

Ebinger, J. E. 1978. Vascular flora of sandstone outcrops in Clark County, Illinois. Castanea (in press).

Ebinger, J. E. and H. M. Parker. 1969. Vegetation survey of an oak-hickory maple forest in Clark County, Illinois. Transactions of the Illinois State Academy of Science 62:379-387.

Ebinger, J. E., P. E. Phillippe, and L. R. Phillippe. 1977. Woody vegetation of an upland forest in Douglas County, Illinois. Castanea 42:285-293.

Eddy, S. 1927. The plankton of Lake Michigan. Bulletin of the Illinois State Natural History Survey 17:203-231.

Eddy, S. 1931*a*. The plankton of some sink hole ponds in southern Illinois. Bulletin of the Illinois State Natural History Survey 19: 449-467.

Eddy, S. 1931*b*. The plankton of the Sangamon River in the summer of 1929. Bulletin of the Illinois State Natural History Survey 19: 469-486.

Eddy, S. 1934. A study of fresh-water plankton communities. Illinois Biological Monographs 12(4):1-93.

Eikenberry, W. L. 1912. Notes on the forests of Ogle County, Illinois. Transactions of the Illinois State Academy of Science 5:121-124.

Engelmann, H. 1863. Remarks upon the causes producing the different characters of vegetation known as prairies, flats, and barrens in southern Illinois, with special reference to observations made in Perry and Jackson counties. American Journal of Science and Arts 86:384-396.

Evans, D. K. 1975. Characteristics of flora and succession in the middle Mississippi River floodplain. Proceedings of the West Virginia Academy of Science 47:7-13.

Evans, D. K. 1978. Floristics of the Mississippi River sand and mud flats. Castanea (in press).

Evers, R. A. 1955. Hill prairies of Illinois. Illinois Natural History Survey Bulletin 26:367-446.

Fell, E. W. 1957. Plants of a northern Illinois sand deposit. American Midland Naturalist 57:441-451.

Fell, E. W. and G. B. Fell. 1949. Ferns of the Rock River valley in Illinois. Transactions of the Illinois State Academy of Science 42:56-62.

Fell, E. W. and G. B. Fell. 1956. The gravel-hill prairies of the Rock River valley in Illinois. Transactions of the Illinois State Academy of Science 49:47-62.

Fell, E. W. and G. B. Fell. 1957. The ravine flora of Winnebago County, Illinois. Transactions of the Illinois State Academy of Science 50:83-89.

Forbes, S. A. and R. E. Richardson. 1908. The fishes of Illinois. Illinois Natural History Survey, Urbana. 357 p.

Forbes, S. A. and R. E. Richardson. 1913. Studies on the biology of the upper Illinois River. Bulletin of the Illinois State Laboratory of Natural History 9:481-574.

Forbes, S. A. and R. E. Richardson. 1919. Some recent changes in Illinois River biology. Bulletin of the Illinois State Natural History Survey 13:139-156.

Fralish, J. S. 1976. Forest site-community relationships in the Shawnee Hills region, southern Illinois. P. 65-87 *in* J. S. Fralish, G. T. Weaver, and R. C. Schlesinger, eds. Central Hardwood Conference, proceedings of the first meeting. Southern Illinois University, Carbondale.

Frankland, L. 1977. Small mammals of the Chain O'Lakes State Park, Lake County, Illinois. P. 44-51 *in* J. E. Ebinger, R. D. Andrews, and H. C. Nilsen, eds. Papers on the ecology of the Chain O'Lakes region, Illinois. Eastern Illinois University, Charleston.

Franz, E. H. 1971. A probabilistic model of a flood plain forest: Prediction of changes in species distribution due to variable backwater conditions during reservoir operation. Ph.D. dissertation. University of Illinois, Urbana-Champaign.

Fuller, G. D. 1925. The vegetation of the Chicago region. University of Chicago Press, Chicago. 27 p.

Fuller, G. D. and P. D. Strausbaugh. 1919. The forests of LaSalle County, Illinois. Transactions of the Illinois State Academy of Science 12:246-272.

Gannon, J. E. 1969. Great Lakes plankton investigations: A bibliography. University of Wisconsin--Milwaukee, Center for Great Lakes Studies Special Report No. 7. 65 p.

Garman, H. 1888. A preliminary report on the animals of the Mississippi bottoms near Quincy, Illinois. Part I. Bulletin of the Illinois State Laboratory of Natural History 3:123-184.

Gates, F. C. 1910. Relic dunes, a life history. Transactions of the Illinois State Academy of Science 3:110-115.

Gates, F. C. 1911*a*. A bog in central Illinois. Torreya 11:205-211.

Gates, F. C. 1911*b*. Summer bird life in the vicinity of Havana, Illinois, in its relation to the prominent plant associations. Wilson Bulletin 23:1-27.

Gates, F. C. 1912. The vegetation of the beach area in northeastern Illinois and southeastern Wisconsin. Bulletin of the Illinois State Laboratory of Natural History 9:255-372.

Geis, J. W. and W. R. Boggess. 1970. Soil-vegetation relationships in a prairie grove remnant. Bulletin of the Torrey Botanical Club 97:196-203.

Geis, J. W., W. R. Boggess, and J. D. Alexander. 1970. Early effects of forest vegetation and topographic position on dark-colored, prairie-derived soils. Soil Science Society of America Proceedings 34:105-111.

Gersbacher, W. M. 1937. Development of stream bottom communities in Illinois. Ecology 18:359-390.

Gleason, H. A. 1909. A vegetational history of a river dune. Transactions of the Illinois State Academy Science 2:19-26.

Gleason, H. A. 1910. The vegetation of inland sand deposits of Illinois. Bulletin of the Illinois State Laboratory of Natural History 9:23-174.

Goff, C. C. 1952. Flood-plain animal communities. American Midland Naturalist 47:478-486.

Greenfield, R. E. 1925. Comparison of chemical and bacteriological examinations made on the Illinois River during a season of low and a season of high water--1923-1924. Illinois Water Survey Bulletin 20:9-33.

Grier, N. M. and J. F. Mueller. 1922-1923. Notes on the naiad fauna of the upper Mississippi. II. The naiades of the upper Mississippi drainage. Nautilus 36:46-94, 96-103.

Griffin, C. D. 1951. Pollen analysis of a peat deposit in Livingston County, Illinois. Butler University Botanical Studies 10:90-99.

Gruger, E. 1972. Pollen and seed studies of Wisconsinan vegetation in Illinois, U.S.A. Geological Society of America Bulletin 83:2715-2734.

Gunning, G. E. 1955. The fishes of the Horseshoe Lake, Illinois. Master's thesis. Southern Illinois University, Carbondale. 37 p.

Gunning, G. E. and W. M. Lewis. 1955. The fish population of a spring-fed swamp in the Mississippi bottoms of southern Illinois. Ecology 36:552-558.

Hall, R. C. and O. D. Ingall. 1911. Forest conditions in Illinois. Bulletin of the Illinois State Laboratory of Natural History 9:175-253.

Hankinson, T. L. 1910. An ecological study of the fish of a small stream. Transactions of the Illinois State Academy of Science 3:23-31.

Hankinson, T. L. 1913. Distribution of fish in the streams about Charleston, Illinois. Transactions of the Illinois State Academy of Science 6:102-113.

Hankinson, T. L. 1915. The vertebrate life of certain prairie and forest regions near Charleston, Illinois. Bulletin of the Illinois State Laboratory of Natural History 11:281-304.

Hanson, P. C. 1975. A vegetational study of the Gensburg-Markham Prairie. Master's thesis. Northeastern Illinois University, Chicago.

Hanson, P. 1978*a*. A plant survey of the Gensburg-Markham Prairie in Illinois. P. 20 *in* Abstracts of contributed papers for the Sixth North American Prairie Conference. Ohio State University, Columbus.

Hanson, P. 1978*b*. The pre-settlement vegetation of the plain of Glacial Lake Chicago in Cook County, Illinois. P. 20 *in* Abstracts of contributed papers for the Sixth North American Prairie Conference. Ohio State University, Columbus.

Harris, S. E., Jr. and B. D. Allen. 1952. Caves of the Kincaid Limestone near Cobden, Illinois. Transactions of the Illinois State Academy of Science 45:196-207.

Hart, C. A. 1895. On the entomology of the Illinois River and adjacent waters. Bulletin of the Illinois State Laboratory of Natural History 4:149-273.

Hart, C. A. and H. A. Gleason. 1907. On the biology of the sand areas of Illinois. Bulletin of the Illinois State Laboratory of Natural History 7:137-272.

Hatcher, R. C. 1952. Some bryophytes of southern Illinois. Bryologist 55:223-227.

Helms, R. L. and M. T. Jackson. 1973. Effects of ground fire on spring wildflower populations of oak-hickory forests. Transactions of the Illinois State Academy of Science 66(3-4):74-80.

Hempel, A. 1899. A list of Protozoa and Rotifera found in the Illinois River and adjacent lakes at Havana, Illinois. Bulletin of the Illinois State Laboratory of Natural History 5:301-388.

Hickey, M. J. and C. L. Dorge. 1977. Relationships of flood volume to cypress growth. P. 190-197 *in* W. J. Mitsch, C. L. Dorge, and J. R. Wiemhoff. Forested wetlands for water resource management in southern Illinois. University of Illinois Water Resource Center, Urbana.

Hopkins, C. G., J. E. Readhimer, and O. S. Fisher. 1912. Peaty swamp lands; sand and "alkali" soils. University of Illinois Agricultural Experiment Station Bulletin 157:93-131.

Hopkins, W. E. 1969. The vascular flora of Lusk Creek Canyon, Pope County, Illinois. Castanea 34:1-56.

Hosner, J. F. and L. S. Minckler. 1960. Hardwood reproduction in the river bottoms of southern Illinois. Forest Science 6:67-77.

Hosner, J. F. and L. S. Minckler. 1963. Bottomland hardwood forests of southern Illinois--Regeneration and succession. Ecology 44: 29-41.

Hudnut, R. 1952. A mesophytic forest on the upland prairie. Transactions of the Illinois State Academy of Science 45:42-47.

Hughes, D. A. 1977. Wet ground plant communities from the Chain O' Lakes region, Lake County, Illinois. P. 8-14 *in* J. E. Ebinger, R. D. Andrews, and H. C. Nilsen, eds. Papers on the ecology of the Chain O'Lakes region, Illinois. Eastern Illinois University, Charleston.

Hughes, J. T. and J. E. Ebinger. 1973. Woody vegetation survey of Rocky Branch Nature Preserve, Clark County, Illinois. Transactions of the Illinois State Academy of Science 66:44-54.

Hus, H. 1908. An ecological cross section of the Mississippi River in the region of St. Louis, Missouri. Annual Report of the Missouri Botanical Garden 19:127-258.

Hutchison, M. D. 1976. Preservation values of the Big Creek watershed in Hardin County, Illinois. Illinois Nature Preserves Commission, Rockford. 68 p.

Illinois Natural History Survey. 1976. Illinois Coastal Zone Management Program: Component study of biological communities. Urbana. 106 p.

Ingle-Stroh, J. 1977. Aquatic macroinvertebrates and plankton in a cove on the Fox River in the Chain O'Lakes region, Lake County, Illinois. P. 64-79 *in* J. E. Ebinger, R. D. Andrews, and H. C. Nilsen, eds. Papers on the ecology of the Chain O'Lakes region, Illinois. Eastern Illinois University, Charleston.

Isenbarger, J. 1934. A contrast of plant habitats with reference to hydrogen-ion concentration and plant distribution. Transactions of the Illinois State Academy of Science 25:126-128.

Isenbarger, J. 1947. A unique plant habitat in the Chicago area. Friends of our Native Landscape, Winter 1946-1947.

Jackson, M. T. and R. O. Petty. 1971. An assessment of various synthetic indices in a transitional old-growth forest. American Midland Naturalist 86:13-27.

Jewell, M. E. 1920. The quality of water in the Sangamon River. Illinois State Water Survey Bulletin 16:230-246.

Jewell, M. E. 1922. The fauna of an acid stream. Ecology 3:22-28.

Johnson, F. L. and D. T. Bell. 1975. Size-class structure of three streamside forests. American Journal of Botany 62:81-85.

Johnson, W. W. 1970. The resident mammal and bird populations of a sand prairie and forest near Bath, Illinois. Transactions of the Illinois State Academy of Science 63:234-239.

Jones, S. E. 1946. Variations in abundance of certain invertebrates in William Trelease Woods, 1933-1938. American Midland Naturalist 35:172-192.

Kendeigh, S. C. 1973. The flooding pattern in Illinois stream bottomlands: Has it changed since primitive times? Transactions of the Illinois State Academy of Science 66:86-93.

Kennedy, D. and R. H. Mohlenbrock. 1963. Botanical observations and collections on a sandbar in the Ohio River. Castanea 28:58-62.

Kerr, K. and J. White. 1978. A volunteer-supported effort to find and preserve prairie remnants in Illinois cemeteries. P. 21 *in* Abstracts of contributed papers for the Sixth North American Prairie Conference. Ohio State University, Columbus.

Kerr, L. R. 1973. Bat utilization of Limestone Mine Cave and Twin Culvert Cave in Pike County, Illinois. Master's thesis. Western Illinois University, Macomb. 66 p.

Kilburn, P. D. 1959. The forest-prairie ecotone in northeastern Illinois. American Midland Naturalist 62:206-217.

Kilburn, P. D. and C. D. Ford, Jr. 1963. Frequency distribution of hill prairie plants. Transactions of the Illinois State Academy of Science 56:94-97.

Kilburn, P. D. and D. K. Warren. 1963. Vegetation-soil relationships in hill prairies. Transactions of the Illinois State Academy of Science 56:142-145.

King, F. B. and J. B. Johnson. 1977. Presettlement forest composition of the central Sangamon River basin, Illinois. Transactions of the Illinois State Academy of Science 70:153-163.

Kofoid, C. A. 1903. Plankton studies. IV. The plankton of the Illinois River, 1894-1899, with introductory notes upon the hydrography of the Illinois River and its basin. Part I. Quantitative investigations and general results. Bulletin of the Illinois State Laboratory of Natural History 6:95-629.

Kofoid, C. A. 1908. Plankton studies. V. The plankton of the Illinois River, 1894-1899. Part II. Constituent organisms and their seasonal distribution. Bulletin of the Illinois State Laboratory of Natural History 8:2-361.

Kothandaraman, V. and R. L. Evans. 1977*a*. An assessment of water quality in the Spoon River, Part I. Transactions of the Illinois State Academy of Science 70:253-271.

Kothandaraman, V. and R. L. Evans. 1977*b*. An assessment of water quality in the Spoon River, Part 2. Transactions of the Illinois State Academy of Science 70:272-284.

Kothandaraman, V. and R. A. Sinclair. 1975. Water quality characteristics of the Illinois River at Peoria. Transactions of the Illinois State Academy of Science 68:230-241.

Krull, J. N. and W. A. Hubert. 1973. Seasonal abundance and diversity of benthos in a southern Illinois swamp. Chicago Academy of Sciences Natural History Miscellanea 190. 4 p.

Kumler, M. L. 1973. Forest communities in a natural site at Union Hill, and comparisons with other forests in Illinois. Transactions of the Illinois State Academy of Science 66(1-2):3-15.

Kurz, D. R. 1978. Limestone glades in southern Illinois. P. 12-13 *in* Abstracts of contributed papers for the Sixth North American Prairie Conference. Ohio State University, Columbus.

Kurz, H. 1923. Hydrogen ion concentration in relation to ecological factors. Botanical Gazette 76:1-29.

Kurz, H. 1928. Influence of sphagnum and other mosses on bog reactions. Ecology 9:56-69.

Lackey, J. B. 1944. Quality and quantity of plankton in the south end of Lake Michigan in 1942. Journal of the American Water Works Association 36:669-674.

Lara, O. G. 1970. Low-flow frequencies of Illinois streams. Report by Illinois Division of Waterways, in cooperation with U. S. Geological Survey. 317 p.

Larimore, R. W. and P. W. Smith. 1963. The fishes of Champaign County, Illinois, as affected by 60 years of stream changes. Illinois Natural History Survey Bulletin 28:299-382.

Larimore, R. W., Q. H. Pickering, and L. Durham. 1952. An inventory of the fishes of Jordan Creek, Vermilion County, Illinois. Illinois Natural History Survey Biological Notes No. 29. 26 p.

Leonard, A. B. 1974. Chronology and molluscan paleontology of two post-Woodfordian bogs in northeastern Illinois. Illinois State Geological Survey Circular 487. 28 p.

Lewis, W. M. 1954. The fish population of the main stream of the Big Muddy River. Transactions of the Illinois State Academy of Science 47:20-24.

Lewis, W. M. 1957. The fish population of a spring-fed stream system in southern Illinois. Transactions of the Illinois State Academy of Science 50:23-29.

Liang, C. 1970. The soil microfungi of Burton Cave, Adams County, Illinois. Master's thesis. Western Illinois University, Macomb. 45 p.

Lin, S. D., R. L. Evans, and D. B. Beuscher. 1973. Algae in the Spoon River, Illinois, 1971-1972. Water Resources Bulletin 9:1112-1124.

Lin, S. D., R. L. Evans, and D. B. Beuscher. 1974. Bacteriological assessment of Spoon River water quality. Applied Microbiology 28:288-297.

Lindenborg, R. G. 1941. Fluctuations in the abundance of small mammals in east-central Illinois, 1936-1939. Ecology 22:96-99.

Lindsey, A. A. 1962. Analysis of an original forest of the lower Wabash floodplain and upland. Proceedings of the Indiana Academy of Science 72:282-287.

Lipsey, L. L., Jr. 1975. Notes on the diatom flora of Kane County, Illinois. I. Fox River at Elgin. Transactions of the Illinois State Academy of Science 68:339-346.

Long, C. A. 1968. Populations of small mammals on railroad right-of-way in prairie of central Illinois. Transactions of the Illinois State Academy of Science 61:139-145.

Lowrie, D. C. 1942. The ecology of the spiders of the xeric dunelands in the Chicago area. Bulletin of the Chicago Academy of Sciences 6:161-189.

Luce, W. M. 1933. A survey of the fishery of the Kaskaskia River. Illinois Natural History Survey Bulletin 20:71-123.

Luvall, J. C. and G. T. Weaver. 1978. Variability in forest floor components in southwestern Illinois upland forests. P. 87-105 *in* P. E. Pope, ed. Central Hardwood Forest Conference II proceedings. Purdue University, West Lafayette, Indiana.

McClain, W. E. and J. E. Ebinger. 1968. Woody vegetation of Baber Woods, Edgar County, Illinois. American Midland Naturalist 79: 419-428.

McConas, M. R., J. P. Kempton, and K. C. Hinkley. 1972. Geology, soils, and hydroecology of Volo Bog and vicinity, Lake County, Illinois. Illinois State Geological Survey Environmental Geology Notes 57. 27 p.

McDonald, F. E. 1900. A sand dune flora of central Illinois. Plant World 3:101-103.

McDougall, W. B. 1919. The forests of Vermilion County. Transactions of the Illinois State Academy of Science 12:282-289.

McDougall, W. B. 1920. A comparison of soil temperatures in upland and bottomland forests. Transactions of the Illinois State Academy of Science 13:249-254.

McDougall, W. B. 1922. Symbiosis in a deciduous forest. I. Botanical Gazette 73:200-212.

McDougall, W. B. 1925. Symbiosis in a deciduous forest. II. Botanical Gazette 79:95-120.

McDougall, W. B. and C. Liebtag. 1928. Symbiosis in a deciduous forest. III. Mycorrhizal relations. Botanical Gazette 86:226-234.

Madany, M. H. 1978. Savannas in Illinois. P. 13 *in* Abstracts of contributed papers for the Sixth North American Prairie Conference. Ohio State University, Columbus.

Mathis, B. J. and S. A. Meyers. 1970. Community metabolism in lower Peoria Lake. Transactions of the Illinois State Academy of Science 63:207-213.

Mathis, B. J., J. Z. Taylor, and S. A. Myers. 1969. Primary productivity in an Illinois River flood plain lake. Transactions of the Illinois State Academy of Science 62:362-371.

Meyer, A. H. 1952. Fundamental vegetation of the Calumet Region, northwest Indiana--northeast Illinois. Papers of the Michigan Academy of Sciences, Arts, and Letters 36:177-182.

Miceli, J. G., G. L. Rolfe, D. R. Peltz, and J. M. Edgington. 1977. Brownfield Woods, Illinois: Woody vegetation since 1960. American Midland Naturalist 98:469-476.

Miller, R. B. 1919. Strip survey and growth studies in LaSalle County. Transactions of the Illinois State Academy of Science 12:273-281.

Miller, R. B. 1923. First report on a forestry survey of Illinois. Bulletin of the Illinois State Natural History Survey 14:291-377.

Miller, R. B. and G. D. Fuller. 1922. Forest conditions in Alexander County, Illinois. Transactions of the Illinois State Academy of Science 14:92-108.

Mills, H. B., W. C. Starrett, and F. C. Bellrose. 1966. Man's effect on the fish and wildlife habitat of the Illinois River. Illinois Natural History Survey Biological Notes No. 57. 24 p.

Mitchell, W. D. 1950. Water-supply characteristics of Illinois streams. Illinois Department of Public Works and Buildings, Division of Waterways, Springfield. 311 p.

Mitchell, W. D. 1954. Floods in Illinois: Magnitude and frequency. Illinois Department of Public Works and Buildings, Division of Waterways, Springfield. 386 p.

Mitchell, W. D. 1957. Flow duration of Illinois streams. Illinois Department of Public Works and Buildings, Division of Waterways, Springfield. 189 p.

M'Nutt, W. and G. D. Fuller. 1912. The range of evaporation and soil moisture in the oak-hickory forest association of Illinois. Transactions of the Illinois State Academy of Science 5:127-137.

Mohlenbrock, R. H. 1959. A floristic study of a southern Illinois swampy area. Ohio Journal of Science 59:89-100.

Mohlenbrock, R. H. 1966. A floristics study of Ferne Clyffe State Park. Castanea 31:198-235.

Mohlenbrock, R. H., ed. 1967. A floristics study of Lake Murphysboro State Park, Illinois. Transactions of the Illinois State Academy of Science 60:409-421.

Mohlenbrock, R. H. 1968. A floristics study of Bell Smith Springs, Pope County, Illinois. Transactions of the Illinois State Academy of Science 61:53-79.

Mohlenbrock, R. H. and J. W. Voigt. 1959. A flora of southern Illinois. Southern Illinois University Press, Carbondale. 390 p.

Mohlenbrock, R. H. and J. W. Voigt. 1965. An annotated checklist of vascular plants of the Southern Illinois University Pine Hills field station and environs. Transactions of the Illinois State Academy of Science 58:268-301.

Montgomery, C. E. 1931. Ecology of the mosses of Grand de Tour region of Illinois, with special reference to pH relations. Botanical Gazette 91:225-251.

Moran, R. 1978. Species composition of northeastern Illinois prairie fens. P. 22 *in* Abstracts of contributed papers for the Sixth North American Prairie Conference. Ohio State University, Columbus.

Mortimer, C. H. and G. T. Csanady. 1975. Physical limnology of Lake Michigan. Environmental status of the Lake Michigan region, Volume 2. National Technical Information Service, Springfield, Virginia. 121 p.

Needham, C. E. 1929. Cusps on the beach of Lake Michigan at Evanston, Illinois. Transactions of the Illinois State Academy of Science 22:464-469.

Nilsen, H. C. and R. W. Larimore. 1973. Establishment of invertebrate communities on log substrates in the Kaskaskia River, Illinois. Ecology 54:366-374.

Nyboer, R. W. 1978. The decline of Illinois hill prairies due to grazing. P. 15 *in* Abstracts of contributed papers for the Sixth American Prairie Conference. Ohio State University, Columbus.

Nyboer, R. W. and J. E. Ebinger. 1976. Woody vegetation survey of a terrace forest in east central Illinois. Castanea 41:348-356.

Ozment, J. E. 1967. The vegetation of limestone ledges of southern Illinois. Transactions of the Illinois State Academy of Science 60:135-173.

Paintin, R. D. 1928. The morphology and nature of a prairie in Cook County, Illinois. Transactions of the Illinois State Academy of Science 21:152-175.

Paloumpis, A. A. and W. C. Starrett. 1960. An ecological study of benthic organisms in three Illinois River flood plain lakes. American Midland Naturalist 64:406-435.

Park, O., S. Auerbach, and M. Wilson. 1949*a*. Pselaphid beetles of an Illinois prairie: The fauna, and its relation to the Prairie Peninsula hypothesis. Bulletin of the Chicago Academy of Sciences 8:267-276.

Park, O., S. Auerbach, and M. Wilson. 1949*b*. Further study of the pselaphid beetle population of an Illinois prairie. Anatomical Record 105:110-111.

Park, O., S. Auerbach, and M. Wilson. 1953. Pselaphid beetles of an Illinois prairie: The population. Ecological Monographs 23:1-16.

Parker, H. M. and J. E. Ebinger. 1971. Ecological study of a hillside marsh in east-central Illinois. Transactions of the Illinois State Academy of Science 64:362-369.

Parmalee, P. W. 1967. The fresh-water mussels of Illinois. Illinois State Museum Popular Science Series 8. 108 p.

Peattie, D. C. 1925. Plants of Wolf Lake, Indiana-Illinois. American Botanist 31:94-99.

Peck, S. B. and J. J. Lewis. 1978. Zoogeography and evolution of the subterranean invertebrate faunas of Illinois and southeastern Missouri. NSS [National Speleological Society] Bulletin 40:39-63.

Pelz, D. R. and G. L. Rolfe. 1977. Stand structure and composition of a natural mixed hardwood forest. Transactions of the Illinois State Academy of Science 69:446-454.

Pepoon, H. S. 1909*a*. An ecological survey of the driftless area of Illinois and Wisconsin. School Science and Mathematics 9:441-446, 522-527.

Pepoon, H. S. 1909*b*. The cliff flora of Jo Daviess County. Transactions of the Illinois State Academy of Science 2:32-37.

Pepoon, H. S. 1910. The forest associations of northwestern Illinois. Transactions of the Illinois State Academy of Science 3:143-156.

Pepoon, H. S. 1917. The Primrose Rocks of Illinois. Transactions of the Illinois State Academy of Science 10:159-162.

Pepoon, H. S. 1919. The forest lands of Jo Daviess County. Transactions of the Illinois State Academy of Science 12:183-202.

Phillippe, P. E. and J. E. Ebinger. 1973. Vegetation survey of some lowland forests along the Wabash River. Castanea 38:339-349.

Phipps, R. and J. Speer. 1958. A hillside marsh in east-central Illinois. Transactions of the Illinois State Academy of Science 51: 37-42.

Putz, F. L. and J. E. Thomerson. 1972. The fishes of Prairie du Pont Creek, St. Clair County, Illinois. Transactions of the Illinois State Academy of Science 65:86-90.

Ranft, C. R. and P. D. Kilburn. 1969. Evapotranspiration contrasts between south-facing bluff prairies and north-facing forest. Transactions of the Illinois State Academy of Science 62:85-90.

Reeves, J. T. 1976. Ecology of east-central Illinois hill prairies. Master's thesis. Eastern Illinois University, Charleston. 56 p.

Reichle, D. E. 1969. Distribution and abundance of bog-inhabiting pselaphid beetles. Transactions of the Illinois State Academy of Science 62:233-264.

Reichle, D. E. and W. T. Doyle. 1965. Bryophyte succession in a northern Illinois bog. Bryologist 68:463-470.

Rice, L. A. 1946. Studies on deciduous forest animal populations during a two-year period with differences in rainfall. American Midland Naturalist 35:153-171.

Richardson, R. E. 1921*a*. The small bottom and shore fauna of the middle and lower Illinois River and its connecting lakes, Chillicothe to Grafton: Its valuation; its sources of food supply; and its relation to the fishery. Bulletin of the Illinois State Natural History Survey 13:363-522.

Richardson, R. E. 1921*b*. Changes in the bottom and shore fauna of the middle Illinois River and its connecting lakes since 1913-1915 as a result of the increase, southward, of sewage pollution. Bulletin of the Illinois State Natural History Survey 14:33-75.

Richardson, R. E. 1925*a*. Changes in the small bottom fauna of Peoria Lake, 1920 to 1922. Bulletin of the Illinois State Natural History Survey 15:327-388.

Richardson, R. E. 1925*b*. Illinois River bottom fauna in 1923. Bulletin of the Illinois State Natural History Survey 15:391-422.

Richardson, R. E. 1928. The bottom fauna of the middle Illinois River, 1913-1925: Its distribution, abundance, variation, valuation, and index value in the study of stream pollution. Bulletin of the Illinois State Natural History Survey 17:387-475.

Ridgway, R. 1873*a*. Notes on the vegetation of the lower Wabash valley. III. Woods and prairies of the upland portions. American Naturalist 7:154-157.

Ridgway, R. 1873*b*. The prairie birds of southern Illinois. American Naturalist 7:197-203.

Ridgway, R. 1882. Notes on the native trees of the lower Wabash and White river valleys in Illinois and Indiana. Proceedings of the United States National Museum 5:49-88.

Ridgway, R. 1894. Additional notes on the native trees of the lower Wabash valley. Proceedings of the United States National Museum 17:409-421.

Robertson, P. A. and W. P. Pusateri. 1976. Structural analysis of a stand containing yellowwood in southern Illinois. P. 119-130 *in* J. S. Fralish, G. T. Weaver, and R. C. Schlesinger, eds. Central Hardwood Conference, proceedings of the first meeting. Southern Illinois University, Carbondale.

Rolfe, G. L., M. A. Akhtar, and L. E. Arnold. 1978. Nutrient distribution and flux in a mature oak-hickory forest. Forest Science 24: 122-130.

Root, T. W., J. W. Geis, and W. R. Boggess. 1971. Woody vegetation of Hart Memorial Woods, Champaign County, Illinois. Transactions of the Illinois State Academy of Science 64:27-37.

Ross, H. H. 1963. The dunesland heritage of Illinois. Illinois Natural History Survey Circular 49. 28 p.

Rowe, E. L. 1976. The soil microfungi of the Mississippi River Sand Hills Nature Preserve. Master's thesis. Western Illinois University, Macomb.

Sampson, H. C. 1921. An ecological survey of the prairie vegetation of Illinois. Bulletin of the Illinois State Natural History Survey 13:523-577.

Schlesinger, R. C. 1976. Hard maples increasing in an upland forest stand. P. 177-185 *in* J. S. Fralish, G. T. Weaver, and R. C. Schlesinger, eds. Central Hardwood Converence, proceedings of the first meeting. Southern Illinois University, Carbondale.

Schmoll, H. M. 1919. Ecological survey of forests in the vicinity of Glencoe. Transactions of the Illinois State Academy of Science 12:208-233.

Schwegman, J. E. 1969. Vegetation of some seep springs in the Cretaceous Hills of southern Illinois. Master's thesis. Southern Illinois University, Carbondale. 81 p.

Shackleford, M. W. 1929. Animal communities of an Illinois prairie. Ecology 10:126-154.

Shelford, V. E. 1911*a*. Ecological succession. I. Stream fishes and the method of physiographic analysis. Biological Bulletin 21:9-35.

Shelford, V. E. 1911*b*. Ecological succession. II. Pond fishes. Biological Bulletin 21:127-151.

Shelford, V. E. 1912. Ecological succession. IV. Vegetation and the control of land animal communities. Biological Bulletin 23:59-99.

Shelford, V. E. 1951. Fluctuation of non-forest animal populations in the upper Mississippi Basin. Ecological Monographs 21:149-181.

Sheviak, C. J. and A. Haney. 1973. Ecological interpretations of the vegetation patterns of Volo Bog, Lake County, Illinois. Transactions of the Illinois State Academy of Science 66:99-112.

Short, C. W. 1845. Observations on the botany of Illinois, more especially in reference to the autumnal flora of the prairies. Western Journal of Medicine and Surgery, New Series 3:185-198.

Simmons, L. M. 1921. Forest distribution at the ends of the Lake Chicago beaches. Transactions of the Illinois State Academy of Science 13:226-239.

Singh, K. P. 1971. Model flow duration and streamflow variability. Water Resources Research 7:1031-1036.

Singh, K. P. and J. B. Stall. 1973. The 7-day 10-year low flows of Illinois streams. Illinois State Water Survey Bulletin 57. 24 p. + 11 maps.

Skaggs, D. M. 1973. Occurrence of vespertilionid bats in some natural and man-made caverns of west-central Illinois. Master's thesis. Western Illinois University, Macomb. 53 p.

Skvortzow, B. V. 1937. Diatoms from Lake Michigan. I. American Midland Naturalist 18:652-658.

Slifer, C. 1977. Prairie communities, Chain O'Lakes region, Lake County, Illinois. P. 15-18 *in* J. E. Ebinger, R. D. Andrews, and H. C. Nilsen, eds. Papers on the ecology of the Chain O'Lakes region, Illinois. Eastern Illinois University, Charleston.

Small, E. B. 1973. A study of ciliate Protozoa from a small polluted stream in east-central Illinois. American Zoologist 13:225-230.

Smith, P. W. 1968. An assessment of changes in the fish fauna of two Illinois rivers and its bearing on their future. Transactions of the Illinois State Academy of Science 61:31-45.

Smith, P. W. 1971. Illinois streams: A classification based on their fishes and an analysis of factors responsible for disappearance of native species. Illinois Natural History Survey Biological Notes No. 76. 14 p.

Smith, P. W. 1978. The fishes of Illinois. University of Illinois Press, Urbana. 314 p.

Smith, S. L., R. E. Twillman, and J. E. Thomerson. 1969. The fishes of Piasa Creek, west central Illinois. Transactions of the Illinois State Academy of Science 62:70-79.

Smith, V. G. 1928. Animal communities of a deciduous forest succession. Ecology 9:479-500.

Snow, L. M. 1902. The microcosm of the drift line. American Naturalist 36:855-864.

Solheim, W. G. and W. T. Penfound. 1928. A study of the algae of a freshwater stream. Transactions of the Illinois State Academy of Science 20:85-91.

Springer, L. L. 1930. An ecological study of the forests of the Sangamon River valley of Champaign County. Transactions of the Illinois State Academy of Science 23:188-199.

Stall, J. B. and Y. Fok. 1968. Hydraulic geometry of Illinois streams. University of Illinois, Water Resources Center Research Report No. 15. Illinois State Water Survey, Urbana. 47 p.

Starrett, W. C. 1971. A survey of the mussels (Unionacea) of the Illinois River: A polluted stream. Illinois Natural History Survey Bulletin 30:268-403.

Starrett, W. C. 1972. Man and the Illinois River. P. 131-169 *in* R. T. Oglesby, C. A. Carlson, and J. A. McCann, eds. River ecology and man. Academic Press, New York 465 p.

Starrett, W. C. and A. W. Fritz. 1965. A biological investigation of the fishes of Lake Chatauqua, Illinois. Illinois Natural History Survey Bulletin 29:1-104.

Steagal, M. M. 1926. Some Illinois Ozark ferns in relation to soil acidity. Transactions of the Illinois State Academy of Science 19:113-137.

Stegman, J. L. 1959. Fishes of Kinkaid Creek, Illinois. Transactions of the Illinois State Academy of Science 52:25-36.

Stiernberg, E. J. 1971. Preliminary pollen analysis of Wauconda Bog. Master's thesis. Northern Illinois University, DeKalb.

Stimpson, K. S., J. R. Brice, M. T. Barbour, and P. Howe. 1975. Distribution and abundance of inshore oligochaetes in Lake Michigan. Transactions of the American Microscopical Society 94:384-394.

Strode, W. S. 1892. The Unionidae of Spoon River, Fulton County, Illinois. American Naturalist 26:495-501.

Strohecker, H. F. 1937. An ecological study of some Orthoptera of the Chicago area. Ecology 18:231-250.

Talbot, M. 1934. Distribution of ant species in the Chicago region with reference to ecological factors and physiological toleration. Ecology 15:416-439.

Tarapchak, S. J. and E. F. Stoermer. 1976. Phytoplankton of Lake Michigan. Environmental status of the Lake Michigan region, Volume 4. National Technical Information Service, Springfield, Virginia. 211 p.

Taylor, A. M. 1920. Ecological succession of mosses. Botanical Gazette 69:449-491.

Telford, C. J. 1926. Third report on a forest survey of Illinois. Bulletin of the Illinois State Natural History Survey 16:1-102.

Thomas, B. W. and H. H. Chase. 1887. Diatomaceae of Lake Michigan as collected during the last 16 years from the water supply of the City of Chicago. Notarisia 2:328-330.

Thompson, D. H. and F. D. Hunt. 1930. The fishes of Champaign County. Bulletin of the Illinois State Natural History Survey 19:1-101.

Thompson, R. L. and T. E. Heineke. 1977. Vascular flora of the DeSoto-Hallidayboro railroad prairie strips, Jackson County, Illinois. Transactions of the Illinois State Academy of Science 70:114-127.

Thomson, P. M. and R. C. Anderson. 1976. An ecological investigation of the Oakwood Bottoms Greentree Reservoir in Illinois. P. 45-64 *in* J. S. Fralish, G. T. Weaver, and R. C. Schlesinger, eds. Central Hardwood Conference, proceedings of the first meeting. Southern Illinois University, Carbondale.

Thone, F. 1922. Ecological factors in the region of Starved Rock Illinois. Botanical Gazette 74:345-368.

Thone, F. 1923. Evaporation rates on rock canyon walls. Botanical Gazette 76:419-424.

Torrey, M. S. 1976. Chemistry of Lake Michigan. Environmental status of the Lake Michigan region, Volume 3. National Technical Information Service, Springfield, Virginia. 418 p.

Turner, L. M. 1929. The 1926-27 floods and the Illinois River valley vegetation. Transactions of the Illinois State Academy of Science 22:95-97.

Turner, L. M. 1934*a*. Grassland in the floodplain of Illinois rivers. Transactions of the Illinois State Academy of Science 26:71-72.

Turner, L. M. 1934*b*. Grassland in the floodplain of Illinois rivers. American Midland Naturalist 15:770-780.

Turner, L. M. 1936. Ecological studies in the lower Illinois River valley. Botanical Gazette 97:689-727.

Twomey, A. C. 1945. The bird population of an elm-maple forest with special reference to aspection, territorialism and coactions. Ecological Monographs 15:173-205.

Uetz, G. W. 1976. Gradient analysis of spider communities in a stream-side forest. Oecologia 22:373-385.

Ullrich, F. T. 1915. The relation of evaporation and soil moisture to plant succession in a ravine. Bulletin of the Illinois State Laboratory of Natural History 12:1-16.

U. S. Geological Survey, Water Resources Division. 1978. Water resources data for Illinois, water year 1977. U. S. Geological Survey Water-Data Report IL-77-1. Champaign, Illinois. 436 p.

Van der Schalie, H. and A. Van der Schalie. 1950. The mussels of the Mississippi River. American Midland Naturalist 44:448-466.

Van Oosten, J. 1958. Great Lakes fauna, flora and their environment. Great Lakes Research Commission, Ann Arbor, Michigan. 86 p.

Vestal, A. G. 1913. An associational study of Illinois sand prairie. Bulletin of the Illinois State Laboratory of Natural History 10: 1-96.

Vestal, A. G. 1914. A black-soil prairie station in northeastern Illinois. Bulletin of the Torrey Botanical Club 41:351-363.

Vestal, A. G. 1918. Local inclusions of prairie within forest. Transactions of the Illinois State Academy of Science 11:122-126.

Vestal, A. G. 1919. Preliminary account of the forests in Cumberland County, Illinois. Transactions of the Illinois State Academy of Science 12:234-245.

Vestal, A. G. 1936. Barrens vegetation in Illinois. Transactions of the Illinois State Academy of Science 29:79-80.

Voigt, J. W. and R. H. Mohlenbrock. 1954. Plant communities of southern Illinois. Southern Illinois University Press, Carbondale. 202 p.

Voss, J. 1931. Preliminary report on the paleo-ecology of a Wisconsin and an Illinois bog. Transactions of the Illinois State Academy of Science 24:130-137.

Wang, W. and R. L. Evans. 1971. The behavior of iron in Peoria Lake. Transactions of the Illinois State Academy of Science 64:159-168.

Waterman, W. G. 1919. A preliminary report on the north two tiers of sections in Niles Township, Cook County, Illinois. Transactions of the Illinois State Academy of Science 12:203-207.

Waterman, W. G. 1921. Preliminary report on the bogs of northern Illinois. Transactions of the Illinois State Academy of Science 14: 79-84.

Waterman, W. G. 1923. Bogs of northern Illinois. II. Transactions of the Illinois State Academy of Science 16:214-225.

Waterman, W. G. 1926. Ecological problems from the sphagnum bogs of Illinois. Ecology 7:255-272.

Weaver, G. T. and W. C. Ashby. 1971. Composition and structure of an old-growth forest remnant in unglaciated southwestern Illinois. American Midland Naturalist 86:46-56.

Weese, A. O. 1924. Animal ecology of an Illinois elm-maple forest. Illinois Biological Monographs 9:345-438.

Weise, J. G. 1957. The spring cave-fish, *Chologaster papilliferus*, in Illinois. Ecology 38:195-204.

Wells, L. and A. L. McLain. 1973. Lake Michigan: Man's effect on native fish stocks and other biota. Great Lakes Fishery Commission Technical Report 20. 55 p.

Wetzel, R. M. 1958. Mammalian succession on Midwestern floodplains. Ecology 39:262-271.

Whitaker, J. O., Jr. 1977. Bats of the caves and mines of the Shawnee National Forest, southern Illinois. Transactions of the Illinois State Academy of Science 70:301-313.

White, J. 1971. Vascular flora of the Heron Pond and Wildcat Bluff Nature Preserve and environs. Master's thesis. Southern Illinois University, Carbondale. 116 p.

Wiedman, R. G. and W. Whiteside. 1975. The lichen flora of Rocky Branch Nature Preserve, Clark County, Illinois. Transactions of the Illinois Academy of Science 68:102-117.

Wiemhoff, J. 1977*a*. A hydrology model for Heron Pond. P. 223-232 *in* W. J. Mitsch, C. L. Dorge, and J. R. Wiemhoff. Forested wetlands for water resource management in southern Illinois. University of Illinois Water Resource Center, Urbana.

Wiemhoff, J. 1977*b*. Heron Pond annual water budget. P. 18-67 *in* W. J. Mitsch, C. L. Dorge, and J. R Wiemhoff. Forested wetlands for water resource management in southern Illinois. University of Illinois Water Resource Center, Urbana.

Wiemhoff, J. 1977*c*. The role of Heron Pond and other wetlands in southern Illinois water management. P. 68-90 *in* W. J. Mitsch, C. L. Dorge, and J. R. Wiemhoff. Forested wetlands for water resource management in southern Illinois. University of Illinois Water Resource Center, Urbana.

Winterringer, G. S. and A. G. Vestal. 1956. Rock-ledge vegetation in southern Illinois. Ecological Monographs 26:105-130.

Woods, L. P. 1970. The changing Great Lakes. Field Museum of Natural History Bulletin 49:6-10.

Woodward, J. 1925. Factors influencing the distribution of tree vegetation in Champaign County, Illinois. Ecology 6:150-156.

Wortman, M. 1977. Late summer bird populations in the Chain O'Lakes region, Lake County, Illinois. P. 52-63 *in* J. E. Ebinger, R. D. Andrews, and H. C. Nilsen, eds. Papers on the ecology of the Chain O'Lakes region, Illinois. Eastern Illinois University, Charleston.

Wunderlin, F. F. and R. P. Wunderlin. 1962. A preliminary survey of the algae flora of Horseshoe Lake, Alexander County, Illinois. American Midland Naturalist 79:534-538.

Yaeger, L. E. 1949. Effect of permanent flooding on a river-bottom timber area. Illinois Natural History Survey Bulletin 25:33-66.

Zales, W. M. 1971. Bryophytes of Goose Lake Prairie, Illinois. Transactions of the Illinois State Academy of Science 64:222-224.

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References Cited in the Text of this Appendix

Bohlen, H. D. 1978. An annotated checklist of the birds of Illinois. Illinois State Museum Popular Science Series, Volume 9. 156 p.

Illinois Nature Preserves Commission. 1975. Illinois Nature Preserves two-year report, 1973-1974. Rockford. 76 p.

Jones, J. K., Jr., D. C. Carter, and H. H. Genoways. 1975. Revised checklist of North American mammals north of Mexico. Occasional Papers of the Museum, Texas Tech University 28. 14 p.

Mohlenbrock, R. H. 1975. Guide to the vascular flora of Illinois. Southern Illinois University, Carbondale. 494 p.

Schwegman, J. E., G. B. Fell, M. Hutchison, G. Paulson, W. M. Shepherd, and J. White. 1973. Comprehensive plan for the Illinois Nature Preserves Commission, Part 2--The Natural Divisions of Illinois. Illinois Nature Preserves Commission, Rockford. 32 p. + map.

Smith, P. W. 1961. The amphibians and reptiles of Illinois. Illinois Natural History Survey Bulletin 28:1-298.

Smith, P. W. 1978. The fishes of Illinois. University of Illinois Press, Urbana. 314 p.

Soil Survey Staff. 1953. Soil survey manual. U. S. Department of Agriculture Handbook 18. 503 p.

Worthen, A. J., director. 1866. Geological survey of Illinois, Volume I, Geology. [Springfield.] 504 p.

Appendix 31.
MONITORING NATURAL AREAS

Natural areas could be periodically inspected for threats to their integrity by ground surveys, by aerial surveys, or by interpreting satellite images. The following estimates of survey times and expenses are based on the Inventory's experience, and they could be readily refined after the actual work begins.

Means of Monitoring Areas

Ground surveys

Perhaps three areas could be inspected thoroughly in a day with on-site visits. Travel might average 100 to 150 miles per day, and two overnight stays away from home might be expected in a week. The actual expenditures would vary considerably in different parts of the state, depending on the distribution and accessibility of areas.

Aerial surveys

All the natural areas in the state could probably be checked with 21 flights, originating from four different airports. The flights would average about 6.6 hours, and airplane and pilot fees of $36 to $46 per hour can be expected for Cessna 172 aircraft. A total of 1 day might be required to both prepare for each flight and process the information after the flight.

Satellite images

Landsat images could be used to monitor large-scale changes in land use in or near natural areas. All of Illinois is imaged every 18 days. Twelve images would be required for the entire state. Prints at the scale of 1:250,000 might be the most useful for interpretation work, but smaller transparencies could be examined with a light table and a magnifying lens. Changes in land use would be most apparent by comparing images of the same area acquired on different dates. A set of 1977 images could be acquired, and newer images could periodically be compared with these. One set of images would cost about $600 for 1:250,000 scale prints

or $180 for 1:1,000,000 scale transparencies. Interpretation should require one person less than a week.

Conclusion

Landsat images would allow only very general surveillance, because most disturbances would be overlooked and the ones that could be detected would often require field investigations to substantiate. Aerial surveys would provide adequate information at the lowest cost. Ground surveys are much more expensive and are not practical for thorough inspections of many areas. One minute's observation from an airplane can reveal changes on the natural area or adjacent land that might be overlooked by a full day's search on the ground. An airplane is very fast for traveling between areas, and arrangements do not need to be made with landowners. The aerial survey would be most effective if it employed persons experienced with the natural areas and with aerial survey techniques.

Appendix 32.

SCIENTIFIC NAMES OF PLANTS AND ANIMALS MENTIONED BY COMMON NAME IN THE TEXT

With few exceptions, nomenclature follows Smith (1978) for fishes, Smith (1961) for amphibians and reptiles, Bohlen (1978) for birds, Jones, et al. (1975) for mammals, and Mohlenbrock (1975) for plants.

Plants

Common name	Scientific name
American elm	*Ulmus americana*
Bald cypress	*Taxodium distichum*
Baldcypress	*Taxodium distichum*
Basswood	*Tilia americana*
Beech	*Fagus grandifolia*
Big bluestem	*Andropogon gerardi*
Big-toothed sunflower	*Helianthus grosseserratus*
Black ash	*Fraxinus nigra*
Blackberry	*Rubus*
Black locust	*Robinia pseudoacacia*
Black oak	*Quercus velutina*
Black willow	*Salix nigra*
Bur oak	*Quercus macrocarpa*
Buttonbush	*Cephalanthus occidentalis*
Canada yew	*Taxus canadensis*
Canadian tick-trefoil	*Desmodium canadense*
Cherrybark oak	*Quercus falcata* var. *pagodaefolia*
Chestnut	*Castanea*
Chestnut oak	*Quercus prinus*
Cinnamon fern	*Osmunda cinnamomea*
Clubmoss	*Lycopodium*
Compass plant	*Silphium laciniatum*
Cottonwood	*Populus deltoides*
Cream wild indigo	*Baptisia leucophaea*
Culver's root	*Veronicastrum virginicum*
Downy sunflower	*Helianthus mollis*
Duckweed	*Spirodela* and *Lemna*
Eastern redcedar	*Juniperus virginiana*
Elm	*Ulmus*
European buckthorn	*Rhamnus cathartica*

Common name	Scientific name
Gooseberry	*Ribes*
Green ash	*Fraxinus pennsylvanica* var. *subintegerrima*
Frost aster	*Aster pilosus*
Hackberry	*Celtis occidentalis*
Hawthorn	*Crataegus*
Hay-scented fern	*Dennstaedtia punctilobula*
Hickory	*Carya*
Honey locust	*Gleditsia triacanthos*
Horsetail	*Equisetum*
Indian grass	*Sorghastrum nutans*
Kentucky bluegrass	*Poa pratensis*
Lead plant	*Amorpha canescens*
Little bluestem	*Andropogon scoparius*
Mockernut hickory	*Carya tomentosa*
Multiflora rose	*Rosa multiflora*
Musclewood	*Carpinus caroliniana*
Northern dropseed	*Sporobolus heterolepis*
Northern pin oak	*Quercus ellipsoidalis*
Northern red oak	*Quercus rubra*
Northern white cedar	*Thuja occidentalis*
Nuttall's oak	*Quercus nuttallii*
Oak	*Quercus*
Osage orange	*Maclura pomifera*
Overcup oak	*Quercus lyrata*
Pale coneflower	*Echinacea pallida*
Pasture rose	*Rosa carolina*
Pecan	*Carya illinoiensis*
Persimmon	*Diospyros virginiana*
Pine	*Pinus*
Pin oak	*Quercus palustris*
Poison ivy	*Rhus radicans*
Porcupine grass	*Stipa spartea*
Post oak	*Quercus stellata*
Prairie willow	*Salix humilis*
Prickly ash	*Xanthoxylum americanum*
Red cedar	*Juniperus virginiana*
Red maple	*Acer rubrum*
Red oak	*Quercus rubra*
Red pine	*Pinus resinosa*
River birch	*Betula nigra*
Rosinweed	*Silphium integrifolium*
Sandbar willow	*Salix interior*
Sassafras	*Sassafras albidum*
Scarlet oak	*Quercus coccinea*

Common name	Scientific name
Sedge	*Carex*
Shortleaf pine	*Pinus echinata*
Silver maple	*Acer saccharinum*
Sphagnum moss	*Sphagnum*
Sugarberry	*Celtis laevigata*
Sugar maple	*Acer saccharum*
Sullivantia	*Sullivantia renifolia*
Swamp chestnut oak	*Quercus michauxii*
Sweetgum	*Liquidambar styraciflua*
Sycamore	*Platanus occidentalis*
Tall boneset	*Eupatorium altissimum*
Tall goldenrod	*Solidago canadensis*
Tamarack	*Larix laricina*
Tuliptree	*Liriodendron tulipifera*
Tupelo	*Nyssa aquatica*
Viburnum	*Viburnum*
Virginia cotton sedge	*Eriophorum virginicum*
Water cress	*Nasturtium officinale*
Water featherfoil	*Hottonia inflata*
Water hickory	*Carya aquatica*
Water tupelo	*Nyssa aquatica*
White ash	*Fraxinus americana*
White cedar	*Thuja occidentalis*
White lady's slipper	*Cypripedium candidum*
White oak	*Quercus alba*
White pine	*Pinus strobus*
White prairie clover	*Petalostemum candidum*
White wild indigo	*Baptisia leucantha*
Whorled milkweed	*Asclepias verticillata*
Willow oak	*Quercus phellos*
Wood lily	*Lilium philadelphicum*
Yellow poplar	*Liriodendron tulipifera*

Animals

Common name	Scientific name
Alewife	*Alosa pseudoharengus*
Bald eagle	*Haliaeetus leucocephalus*
Banded killifish	*Fundulus diaphanus*
Banded pygmy sunfish	*Elassoma zonatum*
Banded sculpin	*Cottus carolinae*
Bank swallow	*Riparia riparia*
Bantam sunfish	*Lepomis symmetricus*
Belted kingfisher	*Megaceryle alcyon*
Big brown bat	*Eptesicus fuscus*
Bigmouth buffalo	*Ictiobus cyprinellus*

Animals, cont.

Common name	Scientific name
Black bullhead	*Ictalurus melas*
Black vulture	*Coragyps atratus*
Blackchin shiner	*Notropis heterodon*
Blacknose shiner	*Notropis heterolepis*
Blackspotted topminnow	*Fundulus olivaceus*
Black tern	*Chlidonia nigra*
Bloater	*Coregonus hoyi*
Blue catfish	*Ictalurus furcatus*
Bluebreast darter	*Etheostoma camurum*
Bobcat	*Felis rufus*
Bobolink	*Dolichonyx oryzivorus*
Broad-headed skink	*Eumeces laticeps*
Bullsnake	*Pituophis melanoleucus sayi*
Carp	*Cyprinus carpio*
Cave salamander	*Eurycea lucifuga*
Central mudminnow	*Umbra limi*
Channel catfish	*Ictalurus punctatus*
Cisco	*Coregonus artedii*
Common flicker	*Colaptes auratus*
Common mole	*Scalopus aquaticus*
Common stoneroller	*Campostoma anomalum*
Creek chub	*Semotilus atromaculatus*
Creek chubsucker	*Erimyzon oblongus*
Deer mouse	*Peromyscus maniculatus*
Dickcissel	*Spiza americana*
Dusty hog-nosed snake	*Heterodon nasicus gloydi*
Eastern bluebird	*Sialia sialis*
Eastern chipmunk	*Tamias striatus*
Eastern massasauga	*Sistrurus catenatus catenatus*
Eastern phoebe	*Sayornis phoebe*
Eastern pipistrelle	*Pipistrellus subflavus*
Eastern plains garter snake	*Thamnophis radix radix*
Eastern tiger salamander	*Ambystoma tigrinum tigrinum*
Eastern spadefoot toad	*Scaphiopus holbrooki holbrooki*
Fathead minnow	*Pimephales promelas*
Field sparrow	*Spizella pusilla*
Five-lined skink	*Eumeces fasciatus*
Flathead catfish	*Pylodictis olivaris*
Four-toed salamander	*Hemidactylium scutatum*
Fox squirrel	*Sciurus niger*
Golden shiner	*Notemigonus crysoleucas*
Grasshopper sparrow	*Ammodramus savannarum*
Gray bat	*Myotis grisescens*
Greater prairie chicken	*Tympanuchus cupido*

Animals, cont.

Common name	Scientific name
Green sunfish	*Lepomis cyanellus*
Green treefrog	*Hyla cinerea*
Ground skink	*Scincella laterale*
Hornyhead chub	*Nocomis biguttatus*
Illinois chorus frog	*Pseudacris streckeri illinoiensis*
Illinois mud turtle	*Kinosternum flavescens spooneri*
Indiana bat	*Myotis sodalis*
Indigo bunting	*Passerina cyanea*
Lake chub	*Couesius plumbeus*
Largescale stoneroller	*Campostoma oligolepis*
Lark sparrow	*Chondestes grammacus*
Little brown bat	*Myotis lucifugus*
Longear sunfish	*Lepomis megalotis*
Longnose dace	*Rhinichthys cataractae*
Longnose sucker	*Catastomus catastomus*
Long-tailed salamander	*Eurycea longicauda*
Mole salamander	*Ambystoma talpoideum*
Muskrat	*Ondatra zibithecus*
Ninespine stickleback	*Pungitius pungitius*
Northern crayfish frog	*Rana areolata circulosa*
Northern hog sucker	*Hypentelium nigricans*
Northern fence lizard	*Sceloporus undulatus hyacinthinus*
Paddlefish	*Polyodon spathula*
Pine squirrel	*Tamiasciurus hudsonicus*
Piping plover	*Charadrius melodus*
Plains pocket gopher	*Geomys bursarius*
Prairie kingsnake	*Lampropeltis calligaster*
Prairie vole	*Microtus ochrogaster*
Prothonotary warbler	*Protonotaria citrea*
Red shiner	*Notropis lutrensis*
Red squirrel	*Tamiasciurus hudsonicus*
Redfin shiner	*Notropis umbratilis*
Red-headed woodpecker	*Melanerpes erythrocephalus*
Red-winged blackbird	*Agelaius phoenicus*
River redhorse	*Moxostoma carinatum*
River otter	*Lutra canadensis*
River shiner	*Notropis blennius*
Rough-winged swallow	*Stelgidopteryx ruficollis*
Savannah sparrow	*Passerculas sandwichensis*
Short-tailed shrew	*Blarina brevicauda*
Shovelnose sturgeon	*Scaphirhynchus platorynchus*
Six-lined racerunner	*Cnemidophorus sexlineatus sexlineatus*
Slough darter	*Etheostoma gracile*
Smallmouth bass	*Micropterus dolomieui*

Animals, cont.

Common name	Scientific name
Smooth softshell	*Trionyx muticus muticus*
Southern redbelly dace	*Phoxinus erythrogaster*
Spiny softshell	*Trionyx spinifer*
Spring cavefish	*Chologaster agassizi*
Stonecat	*Noturus flavus*
Suckermouth minnow	*Phenacobius mirabilis*
Summer tanager	*Pirangea olivacea*
Swamp rabbit	*Sylvilagus aquaticus*
Thirteen-lined ground squirrel	*Spermophilus tridecemlineatus*
Turkey vulture	*Cathartes aura*
Upland sandpiper	*Bartramia longicauda*
Vesper sparrow	*Pooecetes gramineus*
Western bird-voiced treefrog	*Hyla avivoca avivoca*
Western kingbird	*Tyrranus verticalis*
White-eyed vireo	*Vireo griseus*
White-footed mouse	*Peromyscus leucopus*
Wood duck	*Aix sponsa*
Wood frog	*Rana sylvatica*
Wood thrush	*Hylocichla mustelina*
Yellow bullhead	*Ictalurus natalis*
Yellow perch	*Perca flavescens*
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*

Appendix 33.

LIST OF MAJOR MEMORANDA, REPORTS, INSTRUCTIONS, AND FORMS

Memoranda, Reports, and Instructions

The written materials are grouped according to the sections of this report. They are listed chronologically within each section.

Section 1. Summary

White, J. 1976. Illinois Natural Areas Inventory procedures and results: A general informational talk. (October. 11 p.) Text of a 1-hour slide presentation.

Section 2. Introduction

Illinois Department of Conservation. 1974. Request for proposals R-1 for an inventory of Illinois natural areas. (November 1. 24 p.)

Section 3. Basic Organization of the Inventory

White, J. 1975. *Sections from* "A proposal to conduct an inventory of natural areas in Illinois." (January 13. P. 5-6, 15-18, 23-66, 85-87, 91-97.) Description of proposed survey methods and classification systems.

Section 4. Natural Area Categories

White, J. 1975. Inventory methods. (December 29. 2 p.) General outline of natural area categories and procedures.

White, J. 1976. Criteria for identifying natural areas. (January. 4 p.)

White, J. 1976. Natural area categories and significant features. (May. 2 p.)

White, J. 1976. Natural area categories. (July. 2 p.)

Section 5. Natural Area Boundaries, Land Condition Classes, and Features

White, J. 1976. Natural area boundaries and land condition classification. (January. 7 p.)

White, J. 1976. Natural area boundaries, land condition classes, and features. (May. 8 p.)

White, J. 1976. Natural area boundaries, land condition classes, and features. (July. 8 p.)

Section 5, *cont.*

White, J. 1977. Significant, exceptional, and notable features. (July 7. 4 p.)

White, J. 1977. Category VII exceptional features. (July 27. 1 p.)

Section 6. Natural Community Classification

White, J. 1976. Natural environments and natural communities. (July 3. 9 p.)

White, J. 1976. Classification--plant communities and natural communities. (December 4. 2 p.)

White, J. 1977. Classification. (June 23. 15 p.)

Madany, M. 1977. Savanna classification and grading. (June 28. 5 p.)

White, J. 1977. Soil moisture classes. (July 2. 2 p.)

White, J. 1977. Community-types and natural communities. (July 11. 3 p.)

White, J. 1977. Classifying natural communities. (July 23. 17 p.)

Madany, M. 1977. Definitions of natural communities. (July 26. 18 p.)

Madany, M. 1978. Natural community classification. (February 28. 16 p.)

White, J. and M. Madany. 1978. Natural community classification. (March. 31 p.)

Section 7. Natural Quality

White, J. 1975. Grading system for natural quality. (December 22. 2 p.)

White, J. 1976. Natural quality description form. (May. 3 p.) Instructions.

White, J. 1976. Grading natural quality. (May. 8 p.)

White, J. 1976. Grading natural quality. (July 4. 3 p.)

White, J. 1976. Grading natural quality. (July 5. 5 p.)

White, J. 1976. Grading natural quality. (July 19. 5 p.)

White, J. 1976. Rating the natural quality of prairies by species diversity and kind of species. (September 23. 9 p.)

Wallace, D. 1976. Evaluating natural quality. (November. 9 p.)

Wilson, K. 1976. Inventory techniques for prairies. (November. 4 p.)

Bacone, J. 1976. Detection of past disturbance in a woodlot. (November 19. 5 p.)

Section 7, *cont.*

White, J. 1976. Forest descriptive terms. (November 22. 1 p.) Clarification of terms.

Wallace, D. 1976. Comments on grazing. (November 31. 2 p.)

Hutchison, M. 1976. Comments about the technical reports. (December 14. 3 p.) Evaluation techniques.

Harty, F. 1977. Grazing disturbances to forests. (January 5. 13 p.)

Hutchison, M. 1977. Technical reports--grazing disturbance. (January 20. 8 p.)

Hutchison, M. 1977. Technical reports--grazing disturbance. (January 20. 4 p.)

Harty, F. 1977. Major tree responses to common cutting methods used in southern Illinois upland forests. (February. 12 p.)

Wallace, D. 1977. Miscellaneous comments for the Illinois Natural Areas Inventory technical report. (March 8. 2 p.) Discusses disturbances and ways of evaluating natural quality.

Madany, M. 1977. Savanna classification and grading. (June 28. 5 p.)

White, J. 1977. Recognizing and grading minor natural communities, etc. (July 7. 4 p.)

Section 8. Compiling Available Information

White, J. 1975. Assistance from District Foresters. (August 22. 1 p.)

White, J. 1975. Pilot study report: Preliminary stages of the Main Survey--Map and aerial photo examination, contacts with local people and agencies. (September 17. 22 p.)

White, J. 1975. Checking information about natural areas from the general public. (November 20. 2 p.)

White, J. 1975. Potential Natural Area Summary Form. (December 22. 3 p.) Instructions.

White, J. 1975. Records and memoranda. (December 22. 1 p.) Instructions.

White, J. 1976. Memoranda. (January 21. 2 p.) Instructions for record-keeping.

White, J. 1976. Potential Natural Area Form, and Map and Aerial Photo Examination Form. (November 17. 5 p.) Instructions.

Hutchison, M. 1976. Comments on Natural Areas Inventory procedure. (December 9. 7 p.) Discusses value of knowledge about the presettlement character of Illinois' natural communities.

Section 8, *cont.*

Kerr, K. 1977. Dr. Robert Evers' files on natural areas. (February 3. 12 p.)

Kerr, K. 1977. Dr. Evers' files. (February 7. 18 p.)

Wallace, D. 1977. Information from the Soil Conservation Service. (April 5. 2 p.)

White, J. 1977. Potential Natural Area Summary Form. (April 6. 4 p.)

White, J. 1977. Potential Natural Area Summary Form. (May 4. 2 p.) Revised instructions.

Section 9. Examining Maps and Aerial Photographs

White, J. 1975. Aerial photo interpretation techniques. (January 13. 3 p.)

White, J. 1975. Description of the *Presettlement Vegetation Atlas* and its use. (January 13. 2 p.)

White, J. 1975. Limitations of the *Natural Divisions of Illinois* map. (January 13. 2 p.)

Hutchison, M. 1975. Suggested procedure for examining maps and aerial photographs as a part of the preparation for the initial field survey of natural areas. (July 21. 6 p.)

White, J. 1975. Pilot study report: Preliminary stages of the Main Survey--Map and aerial photo examination, contacts with local people and agencies. (September 17. 22 p.)

Nyboer, R. 1976. Map and aerial photo examination for hill prairies. (November 1. 3 p.)

Bacone, J. 1976. Map and aerial photo examination procedures. (November 11. 17 p.)

White, J. 1977. Map and aerial photo examination procedures. (January 9. 2 p.) Lists code letters for abbreviated note-taking.

Hutchison, M. 1977. Remote sensing--Comments on the use of high altitude photography and imagery to identify natural areas for the Illinois Natural Areas Inventory. (June 18. 3 p.)

Section 10. Aerial Survey

Hutchison, M. 1975. Information concerning airplanes, types and characteristics. (September 5. 1 p.)

White, J. 1976. Pilot study report: Main Survey--Aerial survey, initial ground survey. (January 1. 7 p.)

White, J. 1976. Evaluating logging disturbances from the air. (April. 1 p.)

White, J. 1976. Evaluating grazing disturbances from the air. (April. 1 p.)

Section 10, *cont.*

Hutchison, M. 1976. Aerial survey procedures. (October 13. 2 p.)

Nyboer, R. 1976. Aerial survey procedures. (November 1. 5 p.)

Bacone, J. 1976. Comments on aerial survey techniques. (November 15. 1 p.)

Wallace, D. 1976. Comments on aerial survey grazing assessment. (December 7. 2 p.)

Nyboer, R. 1976. Additional aerial survey comments. (December 17. 4 p.)

White, J. 1977. Aerial survey. (January 4. 2 p.) Suggestions for preparing flight plan.

White, J. 1977. Seep springs along the Illinois River and Sangamon River. (February 14. 7 p.)

Section 11. Initial Ground Survey

White, J. 1975. Initial ground survey; use of aerial photos. (December 29. 1 p.)

White, J. 1976. Gaining access to land. (February 8. 2 p.)

White, J. 1976. Pilot study report: Main survey--Aerial survey, initial ground survey. (January 1. 7 p.)

White, J. 1976. Safety measures for fieldworkers. (June 24. 1 p.)

Harty, F. 1976. Occupational hazards. (November 10. 2 p.)

Bacone, J. 1976. Possible accidents. (November 15. 1 p.)

Kerr, K. 1976. Safety. (November 15. 2 p.)

Kurz, D. 1976. Special occupational hazards encountered while working. (November 15. 2 p.)

Wallace, D. 1976. Job related hazards in fieldwork. (November 16. 1 p.)

Hutchison, M. 1976. Note on hazards and safety precautions for field survey procedures of Inventory investigators. (November 22. 1 p.)

Nyboer, J. 1976. Safety. (December 5. 1 p.)

Section 12. Final Field Survey

Main Data Form

White, J. 1976-77. Instructions for Main Data Form. (Last edition, July 1977. 8 p.) The Main Data Form was named the Final Field Survey Form in early drafts.

White, J. 1976. Field notes. (June 1. 1 p.) General instructions for recording notes.

Section 12, *cont.*

Main Data Form, cont.

White, J. 1976. Revised final field survey form. (June 25. 2 p.) Discussion of revisions.

White, J. 1976. Final field survey procedures. (June 29. 3 p.) Discussion of various procedural changes.

White, J. 1976. Final field survey form. (July 14. 2 p.) Discussion of revisions.

White, J. 1976. Final field survey form. (July 15. 2 p.) Discussion of optional items.

White, J. 1977. Comments about items on the Final Field Survey Form used in 1976. (February 10. 4 p.)

White, J. 1977. Main Data Form. (June 13. 4 p.) Explanation of certain items.

White, J. 1977. Category I significant/exceptional feature form. (June 22. 6 p.) Instructions.

White, J. 1977. Main Data Form. (August 2. 3 p.) Discussion of various items.

Maps and aerial photos

White, J. 1976. Mapping and measuring land areas. (May. 4 p.)

White, J. 1976. Maps and overlays. (May. 5 p.)

White, J. 1976. Mapping and measuring areas. (July. 3 p.)

White, J. 1976. Maps. (July. 6 p.)

White, J. 1976. Final data: Boundaries of natural areas. (November 27. 2 p.)

White, J. 1977. Boundaries on topographic maps. (May 31. 2 p.)

White, J. 1977. Site maps. (July 1. 2 p.)

Vegetation sampling

White, J. 1976. Vegetation sampling techniques. (May. 1 p.)

White, J. 1976. Woody plant name abbreviations. (June 22. 2 p.)

Hutchison, M. 1977. Sampling of sandstone glades. (July 8. 1 p.)

Kurz, D. 1977. Sampling sandstone glades. (July 11. 2 p.)

White, J. 1977. Sampling sandstone glades. (July 13. 1 p.)

Wallace, D. 1977. Choice of sampling methods. (May 23. 4 p.)

Wallace, D. 1977. Recommended changes in sampling techniques for summer 1977. (May 24. 2 p.)

Wallace, D. 1977. Sampling methodology. (May 25. 13 p.)

Species lists

White, J. 1976. Species lists. (May. 3 p.)

Section 13. Information Collected about the Natural Areas

Main Data Form: General summaries of items

White, J. 1976. Final data. (December 5. 6 p.) Annotated list of information items and sources.

White, J. 1977. Final data. (January 30. 9 p.) Discussion of data items collected for natural areas.

White, J. 1977. Computer entry form. (February 8. 2 p.) Discussion of data items compiled from information in the office.

White, J. 1977. Final data. (May 16. 8 p.) Discussion of items to be computerized.

White, J. 1977. Final data--a tabulation. (July 28. 4 p.) Annotated list of information items.

Hinrichs, M. 1977. Instructions for preparing the Main Data Form for the computer. (August. 6 p.)

White, J. 1977. Final data. (August 1. 3 p.) Discusses which information items were collected for each category of natural area.

Item 3: Reference number

White, J. 1977. Numbering potential natural areas. (February 24. 2 p.)

Item 7: Preservation value score

Schwegman, J. 1976. Inventory data (soils and preservation values). (December 2. 2 p.)

Wallace, D. 1976. Preservation values. (May 12. 3 p.)

White, J. 1977. Priority ranking of natural areas. (November 3. 5 p.)

White, J. 1976. Final data: Preservation values. (November 21. 3 p.)

White, J. 1977. Preservation value score. (November 25. 1 p.)

Item 9: Legal location

White, J. 1976. Describing the location of natural areas. (May. 2 p.)

Hutchison, M. 1976. Land description information. (May 11. 6 p.) Discusses ambiguities and errors in legal land surveys.

Item 11: Stream system

Schwegman, J. 1976. Data for inventory (distance to schools and watersheds). (November 30. 1 p.)

White, J. 1977. Watersheds. (January 13. 4 p.)

White, J. 1976. Final data: Watersheds. (November 15. 2 p.)

Items 18 & 19: Soil associations

White, J. 1976. Final data: Soil associations. (November 21. 1 p.)

Schwegman, J. 1976. Inventory data (soils and preservation values). (December 2. 2 p.)

White, J. 1976. Final data: Soil associations. (December 3. 1 p.)

Item 21: Rarity index

Harty, F. 1977. Rarity index. (May 20. 2 p.)

White, J. 1977. Rarity index. (November 26. 1 p.)

Item 24: Total acreage

White, J. 1977. Acreage grids. (July 9. 2 p.)

Item 25a: SAF cover type

Madany, M. 1977. Classification of SAF forest cover types. (March 21. 6 p.)

Madany, M. 1977. Revised SAF forest cover type key. (March 31. 7 p.)

Item 25b: Plant community

White, J. 1976. Plant communities. (May. 2 p.)

White, J. 1976. Plant communities. (July. 2 p.)

Item 27: Number of owners

White, J. 1977. Final data: Ownership. (May 27. 1 p.)

Item 28: Use of natural area

White, J. 1976. Use categories. (May. 2 p.)

White, J. 1977. Final data: Use categories. (February 3. 3 p.)

Items 32 & 33: Number of nearby schools, and nearest school

White, J. 1976. Final data: Distance to the nearest school. (November 18. 1 p.)

Schwegman, J. 1976. Data for inventory (distance to schools and watersheds). (November 30. 1 p.)

Items 32 & 33: Number of nearby schools, and nearest school, cont.

White, J. 1977. Final data: Schools. (January 18. 4 p.)

White, J. 1977. Final data: Lists of agencies. (January 24. 9 p.)

Item 34: Number of nearby DOC facilities

White, J. 1977. Final data: Department of Conservation land management facilities. (January 18. 3 p.)

White, J. 1977. Final data: Lists of agencies. (January 24. 9 p.)

Item 35: Land management facility

White, J. 1977. Final data: Lists of agencies. (January 24. 9 p.)

Item 36': Management problem description

White, J. 1976. Protection and management. (May. 2 p.)

Harty, F. 1977. Protection and management. (May 18. 4 p.)

Item 39: Discussion of preservation values

White, J. 1977. Instructions for writing the discussion of preservation values. (November 24. 4 p.)

Unnumbered items: Regional planning commission, forest preserve district, conservation district, zoning

White, J. 1976. Final data: Zoning. (November 28. 1 p.)

White, J. 1977. Final data: Lists of agencies. (January 24. 9 p.)

White, J. 1977. Final data: Zoning. (May 30. 3 p.)

Section 14. Category I Survey: Main Survey

White, J. 1975. Estimates of the magnitude of the Main Survey to find natural areas other than railroad prairies and cemetery prairies. (January 13. 3 p.)

White, J. 1976. Comparing newly discovered forests with known natural areas. (April. 1 p.)

White, J. 1976. Searching for Illinois prairies. (February 29. 5 p.) General, nontechnical discussion.

Lewis, J. 1977. Report on biologically significant caves in Illinois. (March 17. 50 p.)

White, J. 1977. "Best of their kind" Category I areas. (July 24. 5 p.)

Section 14. Category I Survey: Main Survey, *cont.*

White, J. 1977. A discussion of potential cave natural areas by county. (November 25. 7 p.)

White, J. 1977. Choosing caves as significant natural communities. (November 26. 3 p.)

White, J. 1977. Criteria for selecting significant cave natural areas. (November 27. 2 p.)

Section 15. Category I Survey: Railroad Prairies

White, J. 1974. Plan for an initial survey to find railroad prairies in Illinois. (November. 70 p.)

White, J. 1975. Estimates of the size and expense of the railroad prairie survey. (January 13. 4 p.)

White, J. 1975. Pilot study report: Railroad prairie survey--Initial field survey. (November 1. 6 p.)

White, J. 1975. Railroad prairie survey: Procedures for the initial ground survey. (November 12. 40 p.)

White, J. 1976. Final report: Railroad prairie survey preliminary stages--Preparation for the field survey, aerial survey, initial ground survey. (February 29. 5 p.)

Section 16. Category I Survey: Cemetery Prairies and Savannas

White, J. 1974. Plan for an initial survey to find cemetery prairies in Illinois. (November. 31 p.)

White, J. 1975. Estimates of the size and expense of the cemetery prairie survey. (January 13. 4 p.)

White, J. 1976. Cemetery prairie survey procedures. (August. 7 p.)

White, J. 1976. Instructions for cemetery prairie survey--Field survey form. (September. 5 p.)

White, J. 1976. Final report: Cemetery prairie survey. (October 13. 7 p.)

Section 17. Category II Survey: Habitats with Rare, Threatened, and Endangered Species

Kerr, K. 1977. Rare, endangered, highly vulnerable, and vulnerable birds. (March 8. 7 p.)

Schwegman, J. 1977. Birds--Natural Areas Inventory. (March 29. 1 p.)

Kerr, K. 1977. Endangered birds. (April 4. 2 p.)

Kerr, K. 1977. Natural area size suggestions from Vernon Kleen. (May 18. 1 p.)

White, J. 1977. Category II animal natural areas. (November 21. 1 p.)

Section 18. Category III Survey: Habitats with Relict Species

Schwegman, J. 1976. Relic communities in Illinois. (January 8. 4 p.) Presents a proposed classification.

Nyboer, R. 1977. Relict survey. (April 28. 5 p.)

Bacone, J. and R. Nyboer. 1977. Relict plants in Illinois. (June 7. 17 p.)

Paulson, G. 1977. Relict plants in Illinois. (June 24. 5 p.)

Sheviak, C. 1977. Relict plants in Illinois. (June 24. 2 p.)

Bacone, J. 1977. Relict plants in Illinois. (July 19. 11 p.)

Section 19. Category IV Survey: Geologic Areas

Willman, H. B. 1978. Participation of the Illinois State Geological Survey in the Illinois Natural Areas Inventory. (February 22. 3 p. + attachments.)

Section 20. Category V Survey: Natural Study Areas

Schwegman, J. 1976. Further clarification of the parameters for inclusion of the "school area" type of natural area in the inventory when they would not qualify on natural character alone. (March 19. 1 p.)

Kerr, K. 1977. Category V natural areas. (Feburary 28. 2 p.)

Bacone, J. 1977. Notes concerning Category V areas. (May 12. 1 p.)

White, J. 1977. School natural areas. (October 5. 3 p.)

White, J. 1977. School natural areas. (October 5. 2 p.)

White, J. 1977. Category V areas. (December 9. 1 p.)

Section 21. Category VI Survey: Unique Natural Areas

Lewis, J. 1977. Report on biologically significant caves in Illinois. (March 17. 50 p.)

Section 22. Category VII Survey: Aquatic Areas

Smith, P. W. and L. M. Page. 1977. Some candidates for outstanding natural wetlands of Illinois. (February 18. 3 p.)

Section 27. Future Needs

Evans, D. 1978. Aerial inspection costs. (August 4. 3 p.)

Hutchison, M. 1978. Time and cost estimates for monitoring natural areas in southern Illinois by aerial survey. (July 31. 1 p.)

Hutchison, M. 1978. Natural area monitoring by aerial survey. (October 24. 4 p.)

Forms

Preliminary survey stages

- Natural area nomination form (for the general public)
- Map and aerial photo examination form (for systematically recording general notes by township and section)
- Potential natural area form (the permanent record for each potential natural area, with entries for recording actions and evaluations at each survey stage)
- Potential natural area summary form (for summarizing sites and evaluations by county)
- Aerial survey flight summary form
- Initial ground survey form (and special, shortened editions for hill prairies and for glades)

Main Survey

- Main data form (includes all data items that are computerized)
- Category I significant/exceptional feature form (for recording detailed observations and text that is not computerized)

Railroad Prairie Survey

- Preliminary data form
- Initial ground survey form
- Sketch map form
- Plant list for initial ground survey (edition for mesic prairie; and edition for wet, dry, or sand prairie)

Cemetery Prairie and Savanna Survey

- Itinerary and summary form (for initial screening of cemeteries by volunteers)
- Field survey form (for final description and evaluation by staff)
- Plant list

Relict and endangered species surveys

- Category II significant/exceptional feature form
- Catetory III significant/exceptional feature form
- Plant list for habitat with relict species

Maps and overlays

Sketch map form

Frosted acetate overlays (with title block, for use with aerial photos)

Clear acetate overlays (with title block, for use with topographic maps)

Vegetation sampling

Forest sampling: Tree basal area

Forest sampling: Tree density

Forest sampling: Sapling and shrub density

Prairie sampling: Frequency (various editions for different prairie communities; adapted for use with other herbaceous communities)

Species lists

Amphibians, reptiles, and mammals

Summer birds

Woody plants

Ferns and fern allies

Blank species list for natural communities (and special lists for specific communities such as sandstone glades)